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A reassessment of the East African ranges of two subspecies of Yellow-fronted Tinkerbird *Pogoniulus chrysoconus* based on a comparison of plumage, biometrics and song

Alexander N. G. Kirschel and Matteo Sebastianelli

Summary

The distribution of the nominate subspecies of Yellow-fronted Tinkerbird *Pogoniulus chrysoconus* has long been thought to extend throughout Uganda south into northwestern Tanzania, with *extoni* replacing it from southwestern Tanzania southwards. But little or no evidence has been available from southern Uganda or western Tanzania to confirm this. We performed fieldwork in Uganda and Tanzania, recording songs, ringing and measuring tinkerbirds and photographing their plumage. Our analyses of plumage, biometrics and bioacoustics reveal that nominate *chrysoconus* was present in most of Uganda, however, in southern Uganda, near Lake Mburo National Park, it was replaced by *extoni*, which extends southwards into Tanzania. Our findings suggest that published distribution maps and descriptions will require revisions.

Keywords: Uganda, Lybiidae, plumage coloration, song, morphology

Introduction

The Yellow-fronted Tinkerbird *Pogoniulus chrysoconus* is a barbet with a widespread distribution in mostly woodland savannah habitat in sub-Saharan Africa (Short & Horne 1988). In East Africa, it is represented by all three subspecies currently recognized in the IOC world bird list (Gill *et al.* 2022). *P. c. chrysoconus*, ranges from southwestern Mauritania east to western Kenya, *P. c. xanthostictus* occurs in Ethiopia, and *P. c. extoni* from South Africa north to southern Tanzania (Short & Horne 2001). Several authors have suggested that the northern extent of the distribution of *P. c. extoni* is southern Tanzania (Short & Horne 1988, Short & Horne 2001), with *P. c. chrysoconus* extending northwards from Gombe Stream and Kibondo (Britton 1980). However, there are no specimen records from western Tanzania or southern Uganda west of Lake Victoria (Snow 1978), to confirm if and where their distributions meet, and whether possible intergrades might occur.

Nominate *chrysoconus* differs morphologically from *extoni* primarily in the former's bright lemon-yellow underparts, whereas in *extoni* the underparts are a greyer, buff-tinged colour. The forecrown is described as yellow-gold in *chrysoconus* and

gold to orange in *extoni* (Short & Horne 2001). Short & Horne (1988) describe *extoni* as slightly larger than *chrysoconus*, but that variation is clinal with birds further south and at higher elevation being larger. This pattern of variation in body size is consistent with Bergmann's rule, which is in accordance with findings in tinkerbirds from across the continent (Sebastianelli *et al.* 2022). No differences in vocalizations have been described.

Yellow-fronted Tinkerbird forms a superspecies with Red-fronted Tinkerbird with which it occurs in parapatry across much of East Africa as well as in southern Africa. Subspecies have long been assigned to one species or another based on forecrown colour, but recent phylogenetic reconstructions using mitochondrial DNA suggest *P. c. chrysoconus* and *P. c. extoni* are not even sister taxa (Nwankwo *et al.* 2019, Kirschel *et al.* 2021). Kirschel *et al.* (2021) proposed that Red-fronted Tinkerbird *Pogoniulus pusillus* is two distinct species based on phenotypic and genetic differences between southern and northern forms, yet nominate *chrysoconus* and *P. c. extoni* are genetically more differentiated in mitochondrial DNA than the two forms of Red-fronted Tinkerbird, suggesting that these northern and southern forms of Yellow-fronted Tinkerbird may also warrant separate species status.

Our aim was to revise the distributions of *P. c. chrysoconus* and *P. c. extoni* based on recent fieldwork in Uganda and Tanzania. We compared morphology, including plumage coloration, and song among individuals sampled in different populations of *P. c. chrysoconus* and *P. c. extoni* and the subspecies of Red-fronted Tinkerbird occurring in the region (*P. p. affinis*, but see Kirschel *et al.* (2021) for a proposed taxonomic revision). Although song differences have not previously been described between populations of Yellow-fronted Tinkerbird, recent work on Red-fronted Tinkerbird found distinct differences between taxa (Kirschel *et al.* 2021), and similar differences could be found between Yellow-fronted Tinkerbird populations.

Methods

Fieldwork was performed in Uganda from 18 May to 5 June and from 16 April 2022 to 8 May 2022 in Pian Upe, Matheniko-Bokora, and Karuma Game Reserves, in community land across northwestern Uganda (around Mount Kei, Otze and Ajai Forest Reserves), in Queen Elizabeth National Park (QENP), in and around Lake Mburo National Park, and in Entebbe. We also traversed much of the area between QENP and Lake Mburo National Park (Fig. 1). Songs were also recorded and observations made in Tanzania from 8 May 2022 to 27 May 2022 in Ibanda Game Reserve, Burigi-Chato National Park, Biharamulo Game Reserve, Geita Forest Reserve and Grumeti Game Reserve as well as on community land.

We recorded songs of Yellow-fronted and Red-fronted Tinkerbirds using a Marantz PMD 661 digital recorder and a Sennheiser MKH 8050 microphone. Tinkerbirds were captured in mist nets using song playback. Birds were measured and ringed then released. Biometrics recorded included body mass, wing, tarsus and tail length, bill length (exposed culmen and from anterior of nares to tip), width, and depth. We also took photographs of the birds to compare plumage characteristics described as being different between these two subspecies (Short & Horne 2001).

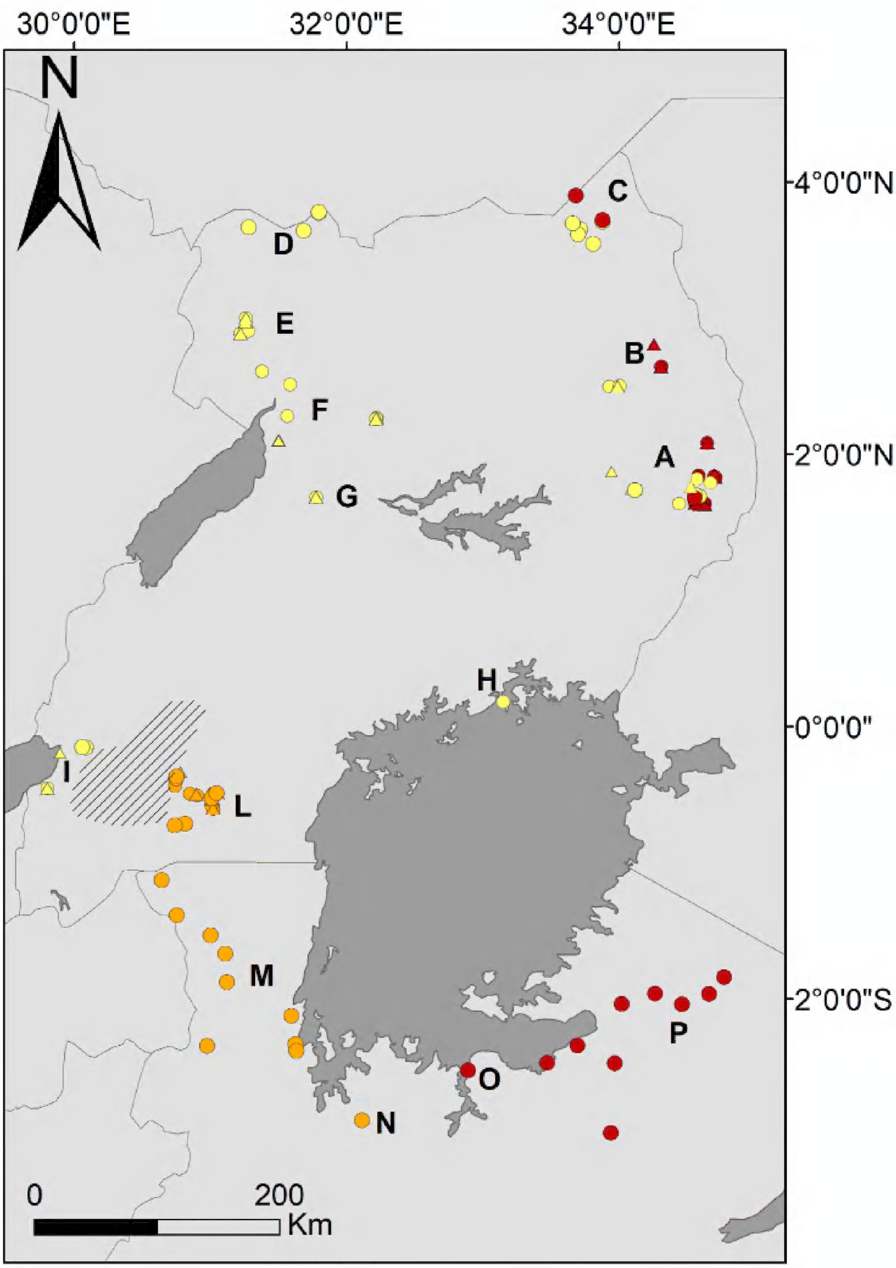

Figure 1. Map of Uganda showing the spatial distribution of recordings (circles) and birds ringed (triangles) for *extoni* (orange), *chrysoconus* (yellow) and *affinis* (burgundy) in (A) Pian Upe, (B) Matheniko-Bokora, (C) Kidepo Valley National Park, (D) Otze forest and Mount Kei, (E) Acha-Ajai, (F) Karuma-Murchison Falls, (G) Masindi, (H) Entebbe, (I) Queen Elizabeth National Park, (L) Lake Mburo National Park, (M) Kagera, (N) Geita, (O) Mwanza and (P) Simiyu / Mara. The hatched lines represent an area where neither *chrysoconus* nor *extoni* were found.

Song analyses

Acoustic measurements were made using the methods described by Sebastianelli *et al.* (2022). In brief, recordings were imported into Raven Pro (Center for Conservation Bioacoustics, 2019) and notes detected using the built-in band limited automated energy detector. The notes were visually inspected to correct any errors in detection. From each detection, the following measurements were extracted: note duration, peak frequency, mean of the peak frequency contour slope, and relative peak time. The inter-onset interval (IOI), a measure of the speed at which notes are delivered, was also calculated from start times of consecutive notes detected.

Statistical analyses

We used Principal Component Analysis to reduce dimensionality in both acoustic and morphological data for use as response variables in Generalized Linear Mixed Models (GLMM) in the *glmmTMB* R package (Brooks *et al.*, 2017). We used peak frequency, delta time, IOI, mean peak frequency slope and peak time relative in the acoustic PCA, and all eight biometrics measured in the morphology PCA. We used PCs with eigenvalues >1 as response variables in gaussian GLMM including presumed subspecies as a fixed factor. For the song models, we used a three-way nested random factor with recording nested in individual, nested in location, whereas for the morphology models we included individual nested in location. The best fit models were validated through graphical inspection using the *DHARMa* package (Harting 2019).

Results

Fieldwork

We analysed 106 recordings, comprising 84 recordings from Uganda (19 *extoni*, 30 *affinis* and 35 *chrysoconus*) and 22 (10 *extoni*, 12 *affinis*) from Northern Tanzania. Specifically, in Uganda we recorded a total of 21 Red-fronted Tinkerbirds and 10 Yellow-fronted Tinkerbirds in Pian Upe, 3 and 2 in Matheniko-Bokora, and 4 and 2 in Kidepo Valley National Park respectively. Four Yellow-fronted Tinkerbirds were recorded in northwestern Uganda and 4 in Karuma/Murchison Falls, 1 near Masindi, 4 between Ajai and Acha, 1 in QENP, 1 in Entebbe, and 19 in the Lake Mburo area, In northern Tanzania, we recorded 10 *extoni* from the Kagera region (west of Lake Victoria) and 12 *affinis* from Mwanza to Mara regions. Moreover, we ringed and obtained biometrics from a total of 31 Red-fronted Tinkerbirds and 10 Yellow-fronted Tinkerbird in the Pian Upe area, 2 and 1 in Matheniko-Bokora, and 9 and 4 in Kidepo respectively, and 5 Yellow-fronted Tinkerbirds in Karuma/Murchison Falls, 1 near Otze forest, 4 between Ajai and Acha, 2 near Masindi, 4 in QENP, and 18 in the Lake Mburo area. We found no Yellow-fronted Tinkerbirds in three days of fieldwork in an area between QENP, Lake Mburo and Katonga Game Reserve (hatched area in Fig. 1).

Statistical analyses

We extracted two principal components from each PCA with eigenvalues >1. For the PCA on song measurements, PC1 was positively associated with IOI and note duration, and PC2 with relative peak time, peak frequency average slope and peak frequency. For the PCA on biometrics, PC1 was negatively associated with the beak

measurements and mass, whereas PC2 was positively associated with beak tip and tarsus (Table 1).

Our results show that *extoni* differed significantly in morphology from *affinis* and *chrysoconus* in PC1 but not in PC2 (Table 2, Fig. 2).

Table 1. Table showing eigenvalues, percentage of variance explained and factor loadings for the principal components with eigenvalues >1 for a) song PCA and b) body PCA.

a) Song	PCI	PC2
Eigenvalue	1.36	1.07
% Variance	37.5	23.17
Peak frequency	-0.28	0.48
Delta frequency	0.54	-0.25
IOI	0.63	-0.13
Average slope	0.38	0.49
Peak time relative	0.27	0.65
b) Morphology	**PCI**	**PC2**
Eigenvalue	1.68	1.22
% Variance	35.43	18.76
Mass	-0.46	0.11
Wing	-0.09	-0.27
Tarsus	-0.22	0.49
Tail	-0.36	0.01
Culmen	-0.07	0.64
Exposed	-0.41	-0.39
Depth	-0.45	0.18
Width	-0.45	-0.24

Table 2. Table showing GLMM output on a) PC1 and b) PC2 extracted from the PCA on biometrics.

	Estimate	Std. Error	z	p
a) Response				
PC1 (51.23%)				
Intercept	-0.240	0.319	-0.753	0.451
P. pusillus affinis	-1.107	0.380	-2.677	0.007
P. chysoconus chrysoconus	2.191	0.397	5.507	<0.001
b) Response				
PC2 (14.36%)				
Intercept	0.179	0.294	0.608	0.543
P. pusillus affinis	-0.064	0.349	-0.185	0.853
P. chysoconus chrysoconus	-0.391	0.369	-1.062	0.288

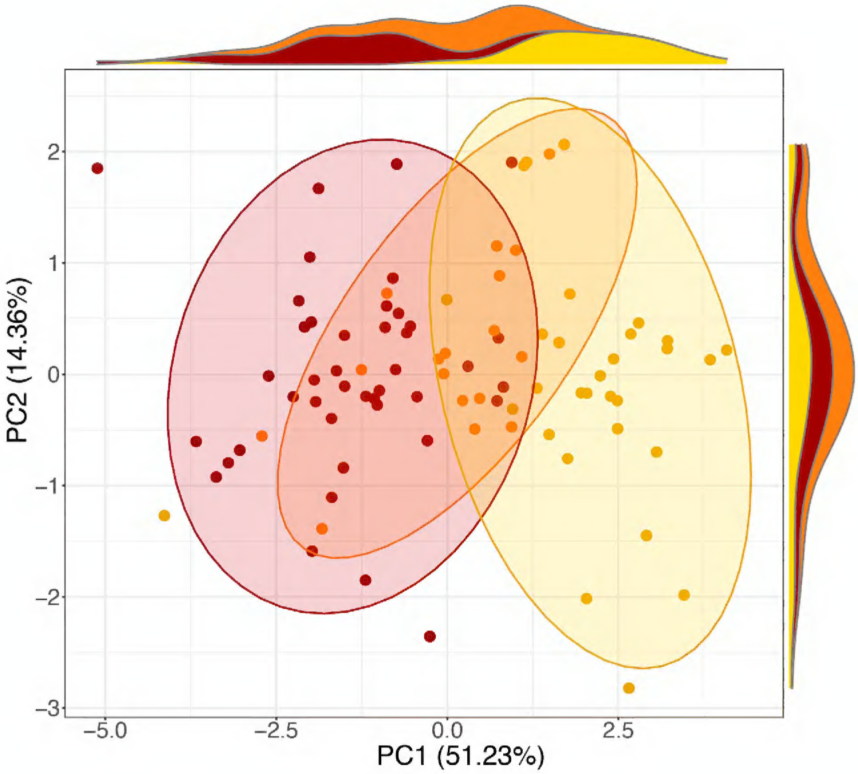

Figure 2. PCA plot on biometrics with 95% CI ellipses. The three taxa are shown in orange (*P. chrysoconus extoni*), burgundy (*P. pusillus affinis*) and yellow (*P. chrysoconus chrysoconus*). Axes show distribution of sample sizes within each taxon for each PC.

Songs of *extoni* were significantly different from those of nominate *chrysoconus*, but not from those of *affinis* according to PC1, with no significant differences in PC2 (Table 3, Fig. 3).

Table 3. Table showing GLMM output on a) PC1 and b) PC2 extracted from the song PCA.

	Estimate	Std. Error	z	p
a) Response				
PC1 (37.50%)				
Intercept	-0.920	0.151	-6.064	<0.001
P. pusillus affinis	0.200	0.195	1.027	0.304
P. chysoconus chrysoconus	2.488	0.203	12.245	<0.001
b) Response				
PC2 (23.17%)				
Intercept	-0.171	0.203	-0.845	0.398
P. pusillus affinis	0.423	0.261	1.622	0.105
P. chysoconus chrysoconus	-0.057	0.272	-0.212	0.832

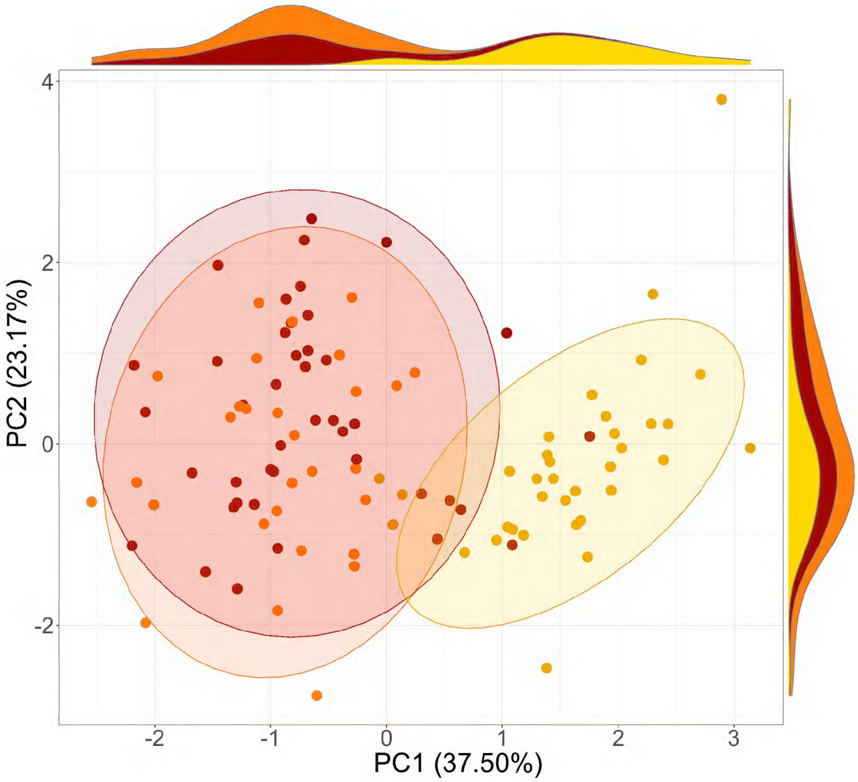

Figure 3. Song PCA plot with 95% CI ellipses showing higher degree of similarity between *P. chrysoconus extoni* (orange) and *P. pusillus affinis* (burgundy) than with *P. chrysoconus chrysoconus* (yellow). Axes show distribution of sample sizes within each taxon for each PC.

Photos of birds in the hand revealed distinct differences in underpart coloration, with individuals from Pian Upe, Kidepo, Murchison Falls, Acha and QENP all with bright lemon-yellow underparts, consistent with nominate *chrysoconus*, and birds from Lake Mburo and its vicinity, all greyer below, consistent with expectations for *extoni* (Fig. 4).

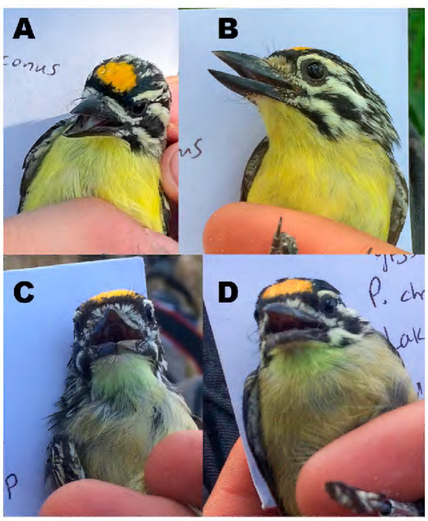

Figure 4. Photos of four Yellow-fronted Tinkerbirds ringed in Uganda in 2021. Underparts of nominate *chrysoconus* from (A) Pian Upe and (B) Acha, are bright lemon yellow in colour, but birds from around the vicinity of Lake Mburo (C, D) have greyer, buff-tinged underparts, consistent with expectations for *P. c. extoni*.

Discussion

In previous fieldwork performed in Tanzania looking for the contact zone between nominate *chrysoconus* and *extoni* in western Tanzania, all individuals of Yellow-fronted Tinkerbird found were clearly *extoni*, based on morphology, and confirmed as such in genomic analyses (Kirschel *et al.* 2020). Searching resources online, photos of Yellow-fronted Tinkerbird from Rwanda on eBird, and a recording from Akagera NP by Lester Short and Jennifer Horne (Macaulay Library), were also identifiable as *extoni* (ANGK pers. obs.) according to distinct song differences between these taxa consistent with our findings in this study. There are also records of a number of species common in Miombo woodland in Tanzania, whose ranges extend into southern Uganda, including within Lybiidae, such as Black-collared Barbet *Lybius torquatus* and Crested Barbet *Trachyphonus vaillantii* (Short & Horne 2001). Therefore, the presence of *extoni* in southern Uganda should not be unexpected.

During our fieldwork in Uganda, having recorded nominate *chrysoconus* at the sites visited prior to arriving at Lake Mburo NP, we had become very familiar with the characteristics of its song. As soon as we heard a tinkerbird song in Lake Mburo NP in May 2021, it was immediately recognized as being much faster than typical nominate *chrysoconus* song. There are records of Yellow-fronted Tinkerbird from Lake Mburo in the *Bird Atlas of Uganda* (Carswell *et al.* 2005), and reports from 2000 and 2001 collected for the atlas even suggested the presence of Red-fronted Tinkerbird in southern Uganda (H. Tushabe pers. comm.). We believe such reports of Red-fronted Tinkerbird from southern Uganda were identified by voice, and were instead the *extoni* form of Yellow-fronted Tinkerbird, whose song is much more similar to Red-fronted Tinkerbird, as shown by our findings here.

Our findings of differences in song and morphology between *extoni* and nominate *chrysoconus* are consistent with the hypothesis that these represent different species, as suggested by Kirschel *et al.* (2021). Although a taxonomic revision is not the aim of the present study, we believe our findings will support any future investigation incorporating genetic data into the species status of these different forms of Yellow-fronted Tinkerbird. If supported, then an additional species would be added to the Uganda bird list.

Despite the extent of genetic differentiation among forms in the Yellow-fronted / Red-fronted Tinkerbird complex, they still commonly interbreed at contact zones, including between Yellow-fronted and Red-fronted Tinkerbirds in southern Africa (Nwankwo *et al.* 2019, Kirschel *et al.* 2020). Although there are distinct song differences between the two forms of Yellow-fronted Tinkerbird in Uganda, and song differences have been shown to elicit differential responses among other tinkerbirds (Kirschel *et al.* 2009, Nwankwo *et al.* 2018), they are likely still similar enough here to allow interbreeding between them if a contact zone exists. Our fieldwork in Uganda did not reveal a contact zone, with intervening areas between their ranges characterized mostly by cultivated areas in shrubland, forest and swamps; but this does not preclude the possibility that a contact zone exists.

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Correlates of flight response in some common birds of a rapidly expanding African city

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Summary

Human disturbance in urban landscapes is well known to influence wildlife species worldwide, but information on some animal taxa such as birds, particularly in sprawling African cities, is scarce. We investigated factors influencing alert distance (AD) and flight initiation distance (FID) for four urban bird species in the expanding Morogoro municipality in northeastern Tanzania. Data were collected along 30 transects, ten in each of urban core, peri-urban and rural zones, and analysed using mixed models. We found starting distance (the initial distance from observer to bird), species type and urbanization levels the strongest predictors of alert distance. The same factors, along with perch height, also best predicted FID. Alert distance was positively related to starting distance, and FID increased with alert distance and perching height. Little Bee-eater *Merops pusillus* showed the longest alert and flight distances, and House Crow *Corvus splendens* and Southern Cordon-bleu *Uraeginthus angolensis* the shortest, with Common Bulbul *Pycnonotus barbatus* intermediate. Encounter rates for House Crow and Southern Cordon-bleu were highest in the urban core, with Little Bee-eater and Common Bulbul preferring more peri-urban and rural settings. The overall responses are consistent with patterns reported in temperate cities, and demonstrate how African bird species variably adjust their behaviours to live in growing African cities. The results may contribute to planning strategies for continued co-existence of birds and humans in expanding urban landscapes.

Keywords: African city, bird-human interaction, disturbance; alert and flight distances; urbanization gradient

Introduction

Rapid development in many areas globally poses potential threats to urban wildlife. Frequent encounters between wildlife and humans in cities require some adaptation to enhance coexistence (König *et al.* 2020). However, the adaptive strategies of urban wild animals vary by taxon group, species, body size and behaviour (Ditchkoff *et al.* 2006). For example, birds are generally more adaptable to such development impacts than most wild large mammals (Isaksson 2018). Even amongst birds, adaptation to environmental disturbance varies between species, based on their habitats and feeding specialization. For example, forest specialist bird species would quickly disappear following forest clearance for development activities, while forest generalists might persist, and non-forest species might become established (Partecke *et al.* 2006). Generalist birds are particularly adaptable to urban areas because they can capitalize on

the anthropogenic changes to their environment: some, such as House Crow *Corvus splendens* can become highly invasive. Understanding how various bird species in the city adapt to disturbances may therefore be useful for designing appropriate conservation plans to improve the provision of ecosystem services by birds (Hedblom *et al.* 2017).

Research on how urban wildlife tolerates human disturbances has mostly focused on measuring responses of animals towards various cues and the influence of environmental variables. For example, studies have investigated flight initiation distances (FID), i.e., the distance at which an individual bird initiates flight when approached by a potential predator such as a human being (Tätte *et al.* 2017). Flight decision is a result of comparison between the costs of fleeing relative to the benefit of staying (Møller *et al.* 2015), consistent with an optimal escape theory that underlies decision making when a predator is encountered (Ydenberg & Dill 1986). Understanding the factors that determine flight distance of birds can help to regulate human-caused disturbances on birds. For example, FID studies have been carried out to establish baseline data for management purposes such as creation of buffer zones (Blumstein *et al.* 2002), walking trails in recreation sites (John 2015) or as indicators of how birds have adapted to coexist with humans in cities (Lin *et al.* 2011). The effect of different environmental factors also reveals varying patterns in the birds' response to predator presence. For instance, Braimoh *et al.* (2017) observed shorter FID of birds inhabiting areas with high human disturbances in Nigeria. In a study in Southern California, perceived predation risk (measured as a function of vigilance and distance to flock size) in the House Finch *Carpodacus mexicanus* was positively correlated with FID in highly urbanized settings but negatively associated with FID in less urbanized areas (Valcarcel & Fernandez-Juricic 2009). Furthermore, habitat characteristics are also known to influence bird FID. For example, Arroyo & Fors (2020) reported positive correlation between bird FID and vegetation cover but negatively correlated with building height in Mexico. Similarly, Rodriguez *et al.* (2001) found vegetation type and distance to vegetation cover significantly affected FID in central Sweden, though in contrast Blumstein *et al.* (2004) who found no correlation between FID and perch height.

Existing literature on FID reports on the variation in response to predators between and within species. Urban birds often become habituated in densely populated human settlements, resulting in shorter FID (Juricic 2002). For example, Møller *et al.* (2015) and Piratelli *et al.* (2015), studying resident temperate-zone birds, found that urban birds generally have shorter FID than their conspecifics in rural habitats. In contrast, both Carrete & Tella (2010) (in Argentina) and Sunde *et al.* (2009) (in Denmark) reported most bird species showed little or no change in FID in relation to proximity to human settlements and human presence. All the studies above were based in temperate regions, but show contrasting patterns suggesting local variability in disturbance levels and mediating factors such as local human culture and human behaviour directed to the birds (Clucas & Marzluff 2012). While variation in study designs may also be a factor (Lowry *et al.* 2013), this suggests that patterns in one region cannot be generalized to all others.

Cities in tropical developing countries are often fast growing and sprawling (Chamberlain *et al.* 2019). The effects on biodiversity are pronounced, including a decline in bird and insect diversity (Chamberlain *et al.* 2016) and native plant diversity (Rija *et al.* 2014a). While many studies document the impacts of urbanization on

overall wildlife populations, relatively little attention has been given on responses of birds towards various disturbance cues in the cities of Africa. Such data, if available, would be useful for improving the conservation outcomes of urban birds and the ecosystem services they offer. The aims of this study, conducted in Morogoro, Tanzania, were (i) to understand the behavioural response to disturbance of different bird species inhabiting the urban ecosystem, and (ii) to investigate the effects of various environmental factors on bird alert and flight initiation distances along an urban-rural-gradient.

Materials and methods

Study area

This study was conducted in Morogoro municipality (6°49′S, 37°39′E) located in Eastern Tanzania (Fig. 1). Morogoro is one of the fastest growing cities in eastern Tanzania with a human population nearing 800 000 residents (P. Kihanga pers. comm., December 2021), an increase of nearly 50 % in the last seven years (Rija *et al.* 2014a). Its rapid growth is partly attributable to its location along major roads connecting the cities of Dodoma, Dar es Salaam and the main highway leading to Mbeya in southern Tanzania. Annual rainfall in the municipality ranges from 750 mm to 1050 mm and is bimodal, with short rains from October to December and a longer rainy season from March to May (Msanya *et al.* 2003). The mean monthly temperature varies from 21 °C to 27 °C through the year.

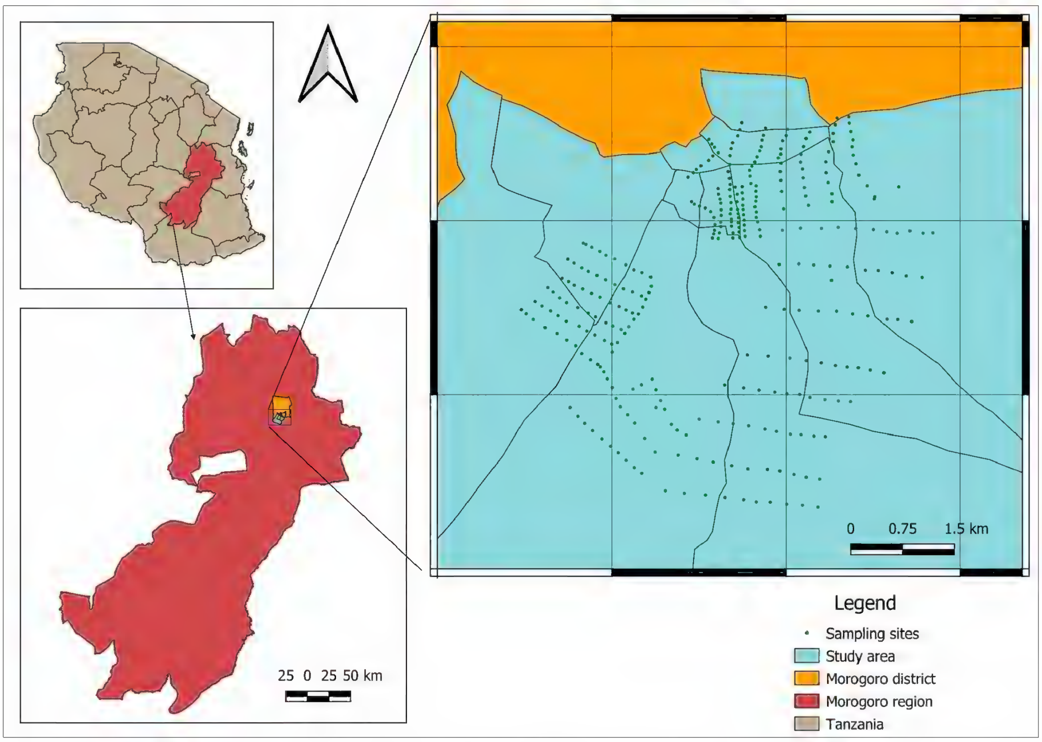


Figure 1. Map of study area in Morogoro Municipality showing the approximate location of the 30 transects where data were collected. Descriptions of the urbanization zones within the study area are provided in the text.

Miombo woodland originally covered much of Morogoro municipality, but this habitat is now heavily modified. For this research, we studied three distinct habitats or urbanization zones following Rija *et al.* (2014a):

1) The urban core, which is now densely built-up (with relatively old buildings), and with most roads and walkways paved and thinly planted trees,

2) The suburbs or peri-urban zone, which is also increasingly built-up but with some open spaces including large backyards with some remnant forest patches (Rija *et al.* 2014a), fruit and ornamental trees to augment any indigenous vegetation, and,

3) A rural-like zone, which is peripheral to the peri-urban zone and characterized by having scattered buildings and large open spaces used for farming and livestock keeping.

Bird species

We selected four focal bird species as models for assessing responses to human disturbances (i.e., approach by a researcher). The selected study species were the Common Bulbul (CB), Southern Cordon-bleu (SCb), Little Bee-eater (LB) and House Crow (HC), all occurring commonly in Morogoro municipality (Rija *et al.* 2014b). None of these species is thought to be subject to substantial human persecution in the study area (Dismas *et al.* 2021), although House Crow is sometimes considered a nuisance and therefore potentially subject to occasional chasing.

Field data collection

Flight Initiation Distances (FID) of the selected bird species were recorded during field observations along transects between 06:30 and 09:30 local time when birds are most active. Ten transects, each 1 km long and 100 m wide, were established in each study zone (urban core, peri-urban and rural) with inter-transect distance of 500 m to avoid double counting. The fieldwork was conducted between 27 December 2019 and 28 March 2020 during the rainy season and each transect was surveyed once over a 2-h period. To collect data, the observer walked slowly along transects, and upon sighting an individual of one of the study species, dropped a marker before moving directly towards the target bird at an average speed of 0.5 ms^{-1} (Samia & Blumstein 2015), while maintaining a direct focus on the target bird(s) (Eason *et al.* 2006). When birds were in a group, only the individual closest to the observer was selected as a target (Piratelli *et al.* 2015). The points at which the target bird detected the observer and begun to show alert behaviour (such as alarm calls, raising up head or tail flicks), was marked by dropping a marker on the ground before continuing the until the target bird took flight (Eason *et al.* 2006). We then took three measures:

- Starting distance, between the first marked point and the position of the target individual when first located.
- Alert distance (AD), between the second marked point and the target individual when alert behaviour was first shown.
- Flight initiation distance (FID), between the position of the observer and the position of the bird when it initiated flight (Blumstein 2003).

All distance measurements over 10 m were taken in metres using a laser rangefinder, while shorter distances were measured directly with a 50-m field tape measure. Details recorded for each observation included: bird species, bird group size, bird activity (preening, resting, foraging or calling), distance to nearest vegetation cover,

perch height, perch substrate (rock, grass, shrub or tree), urbanization zone (urban core, peri-urban or rural) and time of day. Group size was determined by counting the number of individuals within a 10-m radius (Braimoh *et al.* 2017). Distance to the nearest vegetation cover was measured using field tapes or a rangefinder. Only birds that were not showing alert behaviour but engaging in other activities such as foraging or resting on perches were approached (Bjørvick *et al.* 2014).

To ensure consistency in data collection only one observer conducted all the observations across the study zones. Furthermore, to minimize variation of bird response resulting from colour of clothes (Eason *et al.* 2006), the observer wore the same type of clothes throughout the survey period. Observations were only made when there was no other potential factor that could be considered a threat and might influence the escape response of the target bird, such as another person nearby (Eason *et al.* 2006). Approaches were initiated only at positions where there was a clear line of sight between the observer and target bird (Braimoh *et al.* 2017).

Data analysis

A preliminary analysis was conducted by plotting histograms of continuous variables (e.g., FID, alert distance, distance to vegetation cover, perch height) to assess the normality of distribution, and conducting correlation tests to detect potential multicollinearity. Most of the response variables we recorded showed a highly skewed distribution but were not correlated. Because of over-dispersion of our data, we used a mixed model (Generalized linear mixed model—GLMM (vs. a generalized linear model)) with the glmer function in the lme4 package (Bolker *et al.* 2009) using a Poisson distribution and log link function. Two models (with seven and nine fixed factors) were built to check the relevance of including all the variables measured in the field in this analysis. Transect was included in the model as a random factor to account for grouping variables in the model results. Model results were evaluated using the Akaike information criterion (AIC). The best fit was for a nine-variable model with one random factor, which was used for all subsequent analyses. Because bird response to predator approach has been related to FID and alert distance (Blumstein 2003), we further explored models involving these response variables specifically. The predictors included in the models were body mass of study species collated from literature (Dunning 2007), starting distance, perch height, distance to vegetation cover, alert distance (for FID model only), species, bird group size, bird activities and habitat (i.e., urbanization zone).

To determine the predictive variables that most strongly influence AD and FID, backward elimination of non-significant terms was used. To assess the significance of the model upon variable removal, drop1 function and Chi-square tests were used following Braimoh *et al.* (2017). This procedure was repeated until a final model that best fitted the data was reached. A conditional r^2 was calculated to assess how well variance was explained by fixed effects in the final model.

To assess the predictive effect of the explanatory variables on the two dependent variables we built a prediction model for each significant fixed effect to visualize its effect on the bird alert and flight initiation distances using "ggplot2" and "gridExtra" packages available in the R program. Finally, we tested for differences in alert and FID distances between species, habitats and bird activities using a Kruskal Wallis test. Where statistically significant differences were found, a multiple comparison test was performed using a Dunn test, which is appropriate for groups with an unequal number of observations (Zar 2010). All analyses were performed in R ver. 4.1.2. (R Core Team 2021).

Results

Bird observations and behavioural responses of birds

A total of 315 focal bird observations and approaches were conducted in this study, 141 in urban, 85 in peri-urban and 89 in rural habitat. These comprised 103 of Common Bulbul, 92 of Southern Cordon-bleu, 65 of Little Bee-eater and 55 of House Crow (Fig.2a). Combined, target bird approaches were initiated at an average distance of 14.05 m (range: 1–39 m), and birds became alert at an average distance of 9.84 m (range: 3–27 m). The average FID was 7.58 m (range: 1–25 m). Additionally, the average perch height displayed by all species combined was 2.59 m (range: 0–10 m).

During the survey, target birds were initially seen engaged in one of four activities: preening, foraging, calling, and resting (Fig. 2b). We found a significant difference in the frequency of different activity types performed by the four species combined ($\chi^2=19.83$, df=3, $p<0.05$). Birds were observed engaging in significantly more foraging than preening (Dunn test, $z=-2.53$, $p<0.05$) or resting (Dunn test, $z=-4.12$, $p<0.05$). We detected no difference in these behaviours based on urbanization zone. Furthermore, we found variation in alert responses among species particularly when performing foraging and resting activities: Little Bee-eater showed significantly longer AD when foraging ($\chi^2=42.76$, df=3, $p<0.05$), and resting ($\chi^2=50.169$, df=3, $p<0.05$) than the other three bird species (Fig. 3a). Similarly, Little Bee-eater showed significantly longer FID than other bird species during foraging ($\chi^2=57.86$, df=3, $p<0.05$) and resting activities ($\chi^2=56.386$, df=3, $p<0.05$; Fig. 3b).

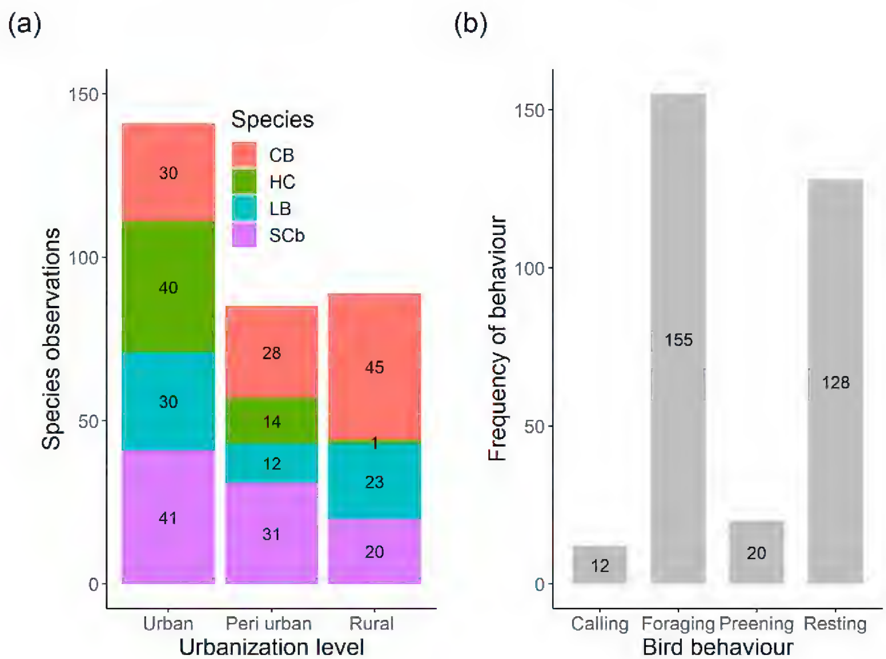


Figure 2. Graphs showing (a) the combined number of focal species encounters by urbanization zone, and (b) the behaviours in which focal birds were initially engaged.

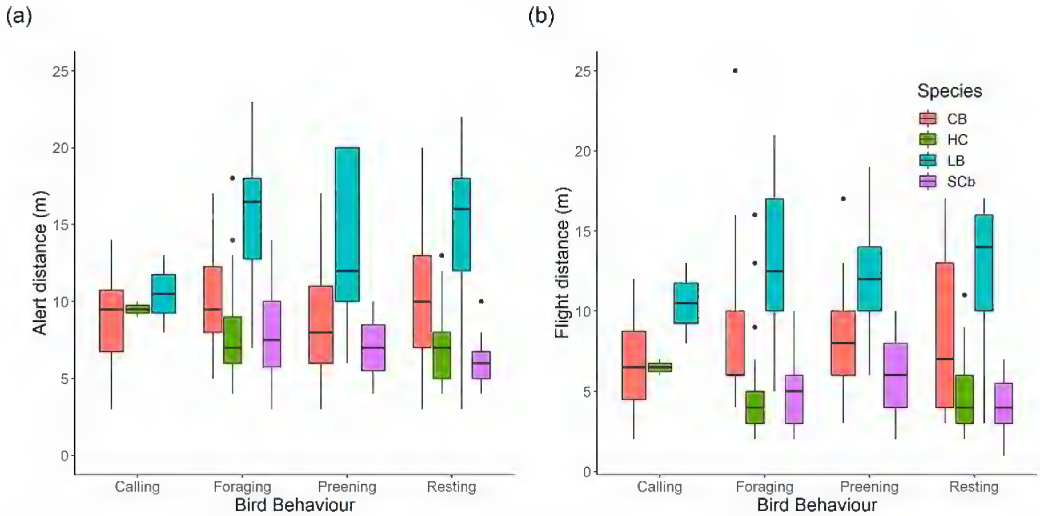
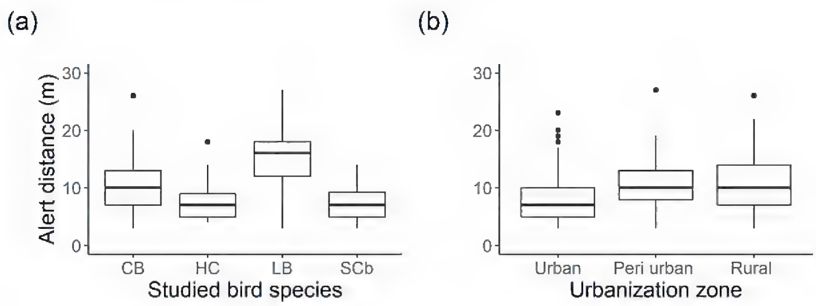


Figure 3. Box plots showing median AD (a) and FID (b) of focal species sampled in relation to behaviour.

Effect of local habitat characteristics and urbanization on alert distance

Alert distance differed significantly by species (Kruskal Wallis test $\chi^2=101.18$, df=3, $p<0.05$; Fig 4a) with Little Bee-eater most alert and Southern Cordon-bleu and House Crow least alert ($z=-0.005$, $p>0.05$). Alert distance also differed significantly across urbanization levels (Kruskal Wallis test $\chi^2=25.17$, df=2, n=315, $p<0.05$, Fig. 4b), being higher in peri-urban and rural than in urban zones. Paired comparisons confirmed differences between the peri-urban and urban zones ($z=4.45$, $p<0.05$) and between rural and urban zones ($z=3.84$, $p<0.05$) but not between the peri-urban and rural zones ($z=0.59$, $p>0.05$). Alert distance was also strongly positively correlated with starting distance ($r=0.819$, $p<0.05$; Fig. 4c).



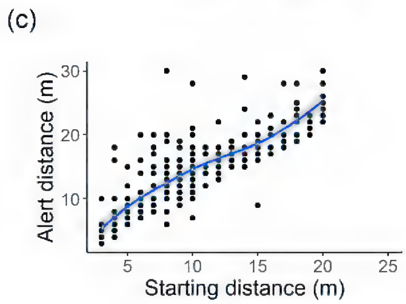


Figure 4. Box plots showing median alert distance by species (a) and urbanization zone (b), and graph showing the relationship between bird alert distance and starting distance (c) in Morogoro municipality. CB=Common Bulbul, HC=House Crow, LB=Little Bee-eater, SCb=Southern Cordon-bleu.

In a combined mixed model, AD was most strongly predicted by starting distance, species and urbanization zone (model AIC=1470.3, n=315, $p<0.05$; Table 1). Across the study area, starting distance increased significantly with AD but this varied by species. Alert distance was mostly likely to be shorter for both Southern Cordon-bleu and House Crow while Little Bee-eater showed significantly longer AD. Conversely, most birds showed generally longer AD in rural and peri-urban zones.

Table 1. Results from best fitting model showing the effect of starting distance, species identity and urbanization levels on alert distance in birds of an urban ecosystem. *$p<0.05$; **$p<0.01$; ***$p<0.001$, HC=House Crow, LB=Little Bee-eater, SCb=Southern Cordon-bleu.

Model item	Estimate	Std error	z-value	AIC	nparameter	p(z)
Intercept	1.58	± 0.059	26.731	430.7		0.0001 ***
Start distance	0.045	±0.003	15.236	1653.3	1	0.0001 ***
Species				**1515.8**	**3**	**0.0001 *** **
-HC	-0.221	±0.061	-3.607			0.0001 ***
-LB	0.143	±0.049	2.926			0.003 **
-SCb	-0.207	±0.05	-4.105			0.0001 ***
Habitat				**1473.8**	**2**	**0.023 * **
-Peri-urban	0.124	±0.045	2.763			0.005 **
-Rural	0.078	±0.045	1.713			0.086
Pseudo R^2	0.570					
Conditional R^2	0.706					

Effect of environmental variables on flight initiation distance (FID)

Flight initiation distance of birds increased significantly from urban to peri-urban to rural zones (Kruskal-Wallis $\chi^2=41.603$, df=2, $p<0.05$; Fig. 5a). Paired comparisons also showed significantly longer FID in rural than urban ($z=6.209$, $p<0.05$), and in peri-urban than urban ($z=3.98$, $p<0.05$), but FID between peri-urban and rural was not significant ($z=-1.939$, $p<0.05$). Additionally, FID also varied across species (Kruskal-Wallis $\chi^2=136.2$, df=3, $p<0.05$). The LB showed longer FID than HC ($z=0.5323$, $p<0.05$), CB ($z=-5.389$, $p<0.05$) and SCb ($z=5.623$, $p<0.05$). Meanwhile, CB showed significantly longer FID than SCb ($z=10.247$, $p<0.05$). The FID was positively correlated with AD ($r=0.937$, $p<0.05$).

In a mixed model, urban zone and alert distance strongly influenced FID, with a smaller residual effect of species and perch height (model AIC=1291.4, n=315, $p<0.05$; Table 2). Both, longer AD and higher perch height were strongly positively associated with FID for the studied birds. FID was mostly likely to be shorter for HC and SCb while it was positively associated with the LB. Furthermore, birds were mostly likely to show higher FID in rural and peri-urban zones than in urban. The relationship between FID and perch height was positive but weak overall ($r=0.291$, $p<0.05$; Fig 5b).

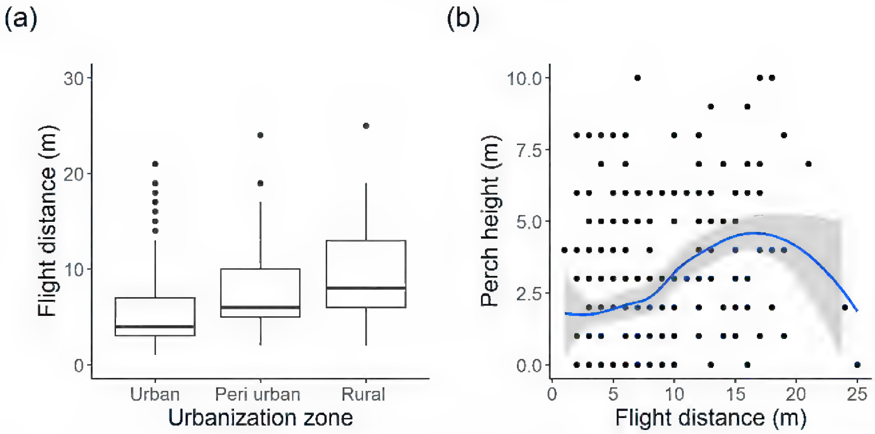


Figure 5. Box plot showing (a) FID based on urbanization zone, and graph showing (b) the relationship between perch height and flight distance.

Table 2. Results from final best fitting GLMM model showing the effect of alert distance, perch height, species identity and urbanization levels on the flight initiation distance by birds in an urban ecosystem. *p<0.05; **p<0.01; ***p<0.001.

Model item	Estimate	Std error	z-value	AIC	n-parameter	p(z)
Intercept	0.920	±0.086	10.593	1291.4		0.0001***
Alert distance	0.089	±0.004	18.27	1593.0	1	0.0001***
Perch height	0.021	±0.009	2.213	1294.3	1	0.026
Species				1292.1	3	0.084
-HC	-0.148	±0.079	-1.856			0.063
-LB	0.044	±0.056	0.799			0.424
-SCb	-0.142	±0.071	-1.980			0.047
Habitat				1300.8	2	0.001**
-Peri-urban	0.111	±0.053	2.071			0.038
-Rural	0.193	±0.052	3.661			0.0001***
Pseudo R2	0.868					
Conditional R2	0.658					

Discussion

This study aimed to describe the pattern of behaviours of birds when approached by a potential predator and to investigate the factors that influence both alert and flight initiation distances in an urban ecosystem. We found bird alertness and flight initiation distance to be consistently variable between species and urbanization types.

House Crow and Southern Cordon-bleu showed the shortest alert and flight distances and Little Bee-eater the longest, with Common Bulbul intermediate. These differences are likely to be related to intrinsic differences in species ecology and behaviour, in the context of an urban landscape. House Crow and Southern Cordon-bleu were most often encountered in the urban core, with Little Bee-eater and Common Bulbul showing preference for less urban zones. Behavioural adaptation towards utilizing resources in areas densely populated by humans may take the form of habituation and reduced wariness of humans approaching (Lord *et al.* 2001, Ikuta & Blumstein 2003). This is despite House Crows being the target for occasional chasing in the study area. Corvids are intelligent birds and may adapt quickly to changing situations (Emery & Clayton 2004, Marzluff & Angell 2005), in this case learning that

approaching humans no longer pose a threat (Marzluff *et al.* 2010 for an account of the American Crow *Corvus brachyrhynchos*).

Longer alert and flight distances in peri-urban and rural zones, compared to the urban core, may be related to lower habituation rates as well as a shift in relative encounter rates between species, with Common Bulbul and Little Bee-eater more common outside the urban core and likely to have been attracted to city gardens with trees and related fruit and insect food resources (Rija *et al.* 2014a, Rija *et al.* 2014c). In Berlin, Seattle and Washington, Clucas & Marzluff (2012) found flight initiation distances of most passerines (including corvids) increased from urban core to rural area, and that bird wariness was influenced by human activities to discourage certain 'nuisance' species, such as crows, starlings and woodpeckers in Seattle.

The relationship between alert distance and starting distance is consistent with previous studies in some temperate countries (Cooper 2005, Blumstein 2003), suggesting that birds are vigilant to any unusual behaviour (in this case, purposeful approach) from humans in the urban ecosystem. The positive correlation of FID with alert distance also suggests that foraging birds prefer to escape a potential threat rapidly rather than incur the energy costs of prolonged monitoring (Cooper *et al.* 2015, Samia *et al.* 2017). Other studies elsewhere have reported similar results to ours: strong positive correlations between FID and alert distance (Møller *et al.* 2015, Stankowich & Coss 2005, Eason *et al.* 2006).

There is no documented current human persecution for most of our focal bird species in the study area. However, in cities where human persecution of wildlife is evident, birds are often vigilant and have relatively longer alert distances (average: 15.58 m) than in our study area (average: 9.84 m), perhaps to avoid being caught or killed (Valcarcel & Fernandez-Juricic 2009). Similarly, in the wild where hunting pressure is high, predation risks associated with hunting or poaching disturbance has been reported to increase AD and FID in the Ostrich *Struthio camelus* (Magige *et al.* 2008).

Our study showed a positive, though not pronounced, relationship between FID and perch height whereby most focal birds perching at an intermediate height of 4.8 m were likely to take flight at a distance of 18 m away from an approaching human (Fig. 5b). This result is of interest particularly in promoting conservation of birds and urban bird tourism, especially in areas designated as urban conservation parks. Managers of urban wildlife resources may be able to implement strategies that improve urban bird biodiversity by encouraging planting of urban trees to be used as perches for the birds, facilitating their ability to detect potential danger and forage (Tätte *et al.* 2017). It is not clear how the height distribution (and use) of potential perches may change with urbanization, for example as large trees become less common, and this is a potential topic for future research.

Implications for species conservation in urban landscapes

Understanding the differences in the behaviour of wildlife along urban-rural gradients has important implications for wildlife management in an increasingly urbanized world. Our study of commonly encountered urban species shows apparent differences in habituation and tolerance of human disturbance, reflected in responses to threats and preferences for different urban zones. One conclusion is that maintaining areas of lower human density and trees within the built-up urban matrix, including cultivated gardens and remnant natural habitats, is likely to be important in maintaining populations of urban wildlife, even for seemingly adaptable species of birds.

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Field characters, taxonomy and distribution of the 'buff-bellied' forms of the Grey Penduline Tit *Anthoscopus caroli* (Sharpe) in East Africa

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Summary

We review the distribution and taxonomy of the buff-bellied subspecies of the Grey Penduline Tit *Anthoscopus caroli* in East Africa using photographs of specimen material as well as of birds in the field. Our study reveals three distinct taxa in the group, including, in addition to the currently recognized *sylviella* of eastern Tanzania and *sharpei* of south-central and western Tanzania, recognition and reinstatement of the form *rothschildi* from eastern Kenya (previously synonymized with *sylviella*). We show that contrary to literature accounts, *sylviella* has richer underparts and darker upperparts than *sharpei*, and the range of *sharpei* extends southeast from Tabora to the Iringa area of Tanzania and not northwards into southwestern Kenya, as had been previously thought. Meanwhile, we extend the range of *sylviella* from eastern Tanzania to areas west of the Rift Valley in the Serengeti National Park of Tanzania as well as southwestern Kenya, both areas previously considered occupied by *sharpei*. We further demonstrate that these two taxa intergrade where they meet in the southern reaches of the Serengeti National Park, and that *sylviella* also intergrades with *rothschildi* across a small area to the east of the Rift Valley in Kenya immediately south of Nairobi. Further work may show birds in the Chyulu Hills, Kenya, to be a distinct form, while birds in the central Kenya Rift Valley remain only tentatively assigned to *sylviella*.

Keywords: *Anthoscopus caroli*, Grey Penduline Tit, taxonomy, distribution, field identification

Introduction

The Grey Penduline Tit *Anthoscopus caroli* Sharpe, 1871 is a small, short-billed and short-tailed bird occurring in wooded habitats throughout much of East Africa and the southern tropical woodland zone from Mozambique west to Angola and south to the eastern parts of South Africa (Fry *et al.* 2000). It is typified by the nominate subspecies which occurs from northern Namibia and southern Angola east through northern Botswana to southwest Zambia and is plain grey above, slightly paler below, and with pale cinnamon-buff forehead, cheeks and vent. The species is currently considered to comprise no fewer than eleven subspecies (Dickinson & Christidis 2014, Clements *et al.* 2019, Gill & Donsker 2020), separable into five groups (Harrap & Quinn 1995, Clements

et al. 2019, Fry *et al.* 2000). Six subspecies have been reported from East Africa, representing four of these groups as follows (Britton 1980, Harrap & Quinn 1995, Fry *et al.* 2000):

1) The ***caroli*** **('Buff-vented') group**, represented in East Africa by the subspecies *A. c. robertsi* Haagner, 1909 (including '*taruensis*' van Someren, 1921), occurring from interior east Tanzania north to Kilosa, Korogwe and Naberera and to southeast Kenya at Taru and Samburu north to the lower Tana River. Similar to nominate , but more olive-grey above; sides of head pale yellowish buff (rather than cinnamon-buff); throat and breast whiter, tinged yellowish; buff lower underparts paler, tinged more yellowish. Wing: 48–54 mm (compared with 51–55 mm in nominate *caroli*). Birds in northeastern Tanzania, inland coastal Kenya ('*taruensis*') average slightly smaller; wing 49–51 mm.
2) The ***ansorgei*** **Hartert, 1905 ('White-bellied') group**, represented in East Africa by two subspecies:
i. *A. c. rhodesiae* Sclater, 1932 occurring in southwest Tanzania from border regions with Zambia north to the Ufipa Plateau. Differs from *A. c. ansorgei* in having forehead paler yellow (vs brighter and richer in *ansorgei*), olive-green upperparts duller (vs brighter apple green), sides of head and chin to breast greyish-white, and rear of underparts pale cinnamon-buff (underparts uniform whitish in *ansorgei*); secondaries, tertials, greater coverts and tail feathers edged pale olive-yellow. Wing: 48–57 mm.
ii. *A. c. pallescens* Ulfstrand, 1960 occurring from Kigoma to the Mahale Mountains in western Tanzania. Like *rhodesiae* but paler, more greyish green above; greyish-white underparts slightly washed yellow, under tail-coverts tinged buff. Wing: 53–57 mm.
3) The ***sylviella*** **Reichenow, 1904 ('Buff-bellied') group**, endemic to East Africa and represented by two subspecies:
i. *A. c. sylviella* Reichenow, occurring from south-central Kenya east of the Rift (Murang'a and Kitui, south to Kajiado, Simba and Voi) and central Tanzania (Longido south to Dodoma, Iringa and the Mbeya-Rungwe District) to the west of *robertsi*. Similar to nominate, with grey upperparts (olive tones faint or absent), but whole underparts tawny-buff to deep tawny-buff, paler on chin and throat; forehead pale buff to deep tawny-buff; sides of head pale buff. Wing: 51–58 mm.
ii. *A. c. sharpei* Hartert, 1905 from southwestern Kenya and northern Tanzania east and south of Lake Victoria (Kakamega and Nyanza to Lolgorien, Masai Mara GR, Serengeti and Usambiro), while birds in the central Kenya Rift at Lake Baringo to the Kerio Valley and Nakuru District probably belong here. Although less distinct, they are almost as richly-marked as *sylviella* and certainly more so than all other forms in the other groups. Like *sylviella*, but darker, more cinnamon below, forehead dull cinnamon. Wing: 54–59 mm.
4) The ***roccatii*** **Salvadori, 1906 ('Yellow-bellied') group**, represented by a single subspecies *A. c. roccatii* Salvadori, from Burundi and Rwanda in the Akanyaru and Kagera basins, north through northwest Tanzania at Kagera to Uganda, east to west Kenya borders (Kongelai and Kapenguria to Bungoma). Upperparts greyish-olive; forehead and superciliary stripe pale yellow; sides of head, chin and throat tinged grey, rest of underparts pale yellow, deeper and buffier on vent and under tail-coverts. Wing: 51–56 mm.

Ranging from central Kenya to southern Tanzania (Fig. 1), the Buff-bellied Penduline Tits addressed in this paper are readily distinguished from all other subspecies by their grey upperparts and warm buffy to clay-coloured underparts, these being off-white to greyish-yellow in other subspecies occurring peripherally to this group, and with any buff tones restricted to the vent and/or forehead and cheeks. In addition to the distinctive underpart colours and an absence of intergrades with non Buff-bellied types, the vocalizations are also described as very different, including a high trill variably reported to be the song or call (Boesman in del Hoyo & Collar 2016). As such, the Buff-bellied types have been considered distinct enough by del Hoyo & Collar (2016) to be elevated to species rank as Buff-bellied Penduline Tit *A. sylviella*. The Buff-bellied Penduline Tit taxa also specialize mostly in *Acacia*-dominant, bush or grassland associations, further differentiating them from other forms of *A. caroli* in East Africa, which occupy other woodland types.

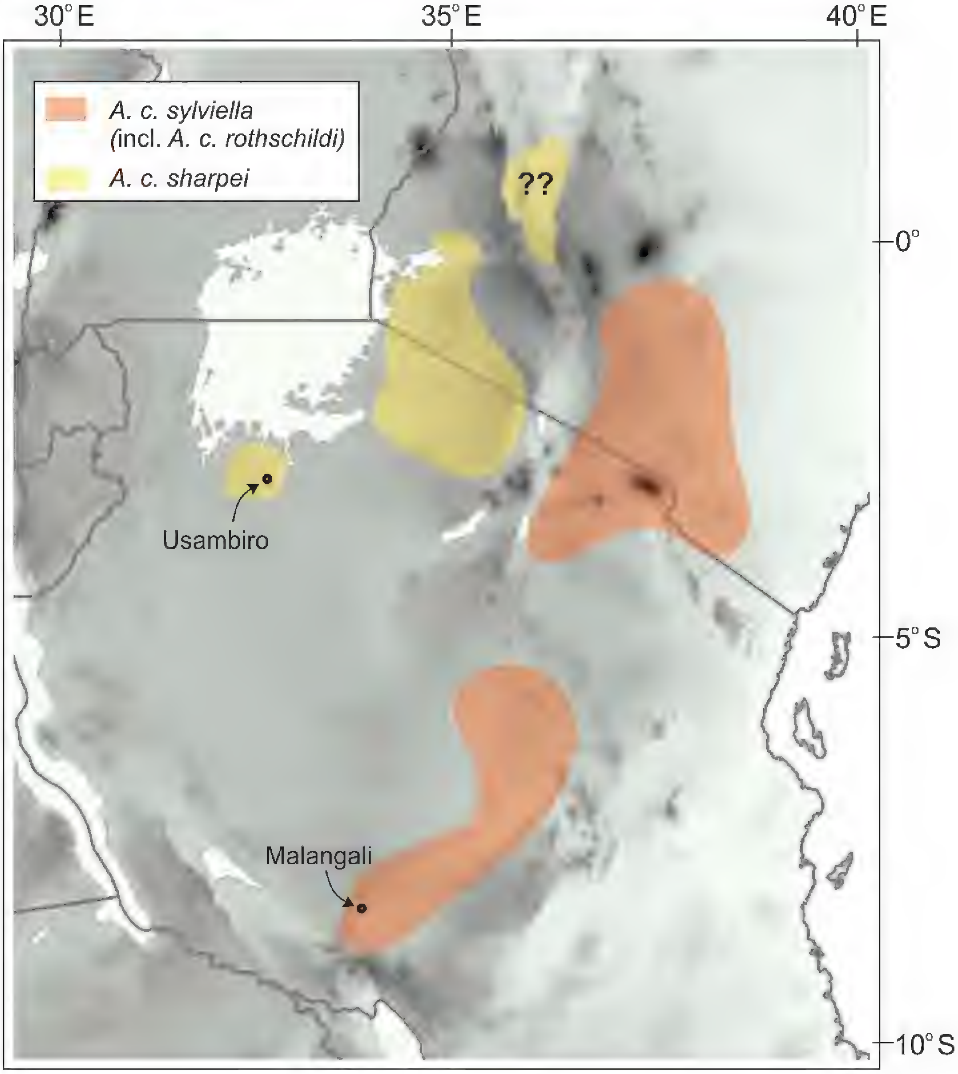

Figure 1. Map showing the currently understood distribution of the forms *A. c. sylviella* and *A. c. sharpei* of the African Penduline Tit in East Africa (distribution adapted from Harrap & Quinn 1995 and Fry *et al.* 2000).

Within the Buff-bellied Penduline Tit complex, the recognition of *sharpei* as distinct from *sylviella* is comparatively recent, with earlier authors preferring to treat it as a synonym of *sylviella*. These include Hellmayr in Wytsman (1911), who concluded that *sharpei* was "not distinct from *sylviella*", followed by Sclater (1930) and Jackson & Sclater (1938), who concluded that *sharpei* was "probably a synonym of *sylviella*". Meanwhile, Hartert (1920) himself stated that "the identity of the two was still doubtful". Since Grant & Mackworth-Praed (1948), however, successive authors have argued that variation in the depth of colour of the underparts is sufficient to distinguish *sylviella* and *sharpei* (e.g. Harrap & Quinn 1995, Fry *et al.* 2000, Madge *et al.* 2020; see descriptions above), maintaining these to be darker in *sharpei* (which also shows a paler throat, cheeks and forehead) and paler in *sylviella*.

However, birds recently photographed in eastern Tanzania at Iringa, where the subspecies has been thought to be *sylviella*, show underparts that are considerably paler than other birds photographed in eastern Tanzania at Tarangire NP (400 km north of Iringa) and also thought to be *sylviella* on the basis of the distribution east of the Rift Valley. However, these birds show rich clay-coloured underparts unlike the pale underparts of birds in Iringa. Additionally, field observations we have made of birds in eastern Kenya, which are widely referred to *sylviella*, show their underparts to be completely lacking in any rusty clay tones at all, *contra* descriptions of *sylviella* and wholly unlike the birds photographed at Tarangire NP. Originally, these east Kenyan birds were described under the name *rothschildi* Neumann, 1907 from a specimen collected at Simba in southeast Kenya. This taxon, however, has not been recognized since White (1963) treated it as a synonym of *sylviella,* without providing his reasoning, though van Someren (1932) did comment that *sharpei* was different from *rothschildi* in being "darker on the belly but lighter on the throat and frontal area". The few details of *rothschildi* are:

> in the eastern districts of Kenya from Ukambani to the Upper Tana River including Simba, Kiu, Kitui, Thika and Murang'a districts (van Someren 1932, Friedmann 1937) *rothschildi* Neumann, 1907, was described as being "much smaller than *sylviella,* with pure ashy grey crown and upper parts, considerably paler ochre-yellow under parts and a rich ochre coloured forehead". Wing: 51.5 mm.

In light of recently obtained field photographs and field observations that conflict with our current understanding of field characters and distributions of the different forms in the Buff-bellied Penduline Tit grouping, a detailed review of the group is warranted. In this paper we assess field photographs and specimen material of the Buff-bellied Penduline Tit subspecies of *A. caroli* in East Africa. We compare type specimens with topotypical field photographs as well as with specimen material and field photographs from elsewhere within the range of *sylviella*, *sharpei* and *rothschildi*. In reviewing this evidence in combination with literature accounts detailing phenotypic variation, as well as the range limits of each subspecies, we ask:

1) Do the subspecies *sylviella* and *sharpei*, with ranges attributed to the east and west of the Rift Valley respectively in Tanzania and Kenya, comprise two recognizable subspecies, and if so, and what are their distinguishing field characters?
2) Is *rothschildi*, currently subsumed into *sylviella*, a recognizable taxon, and if so, what are its distinguishing field characters?

3) Is there evidence of intergrading between any of these subspecies and can all birds occurring within their ranges be satisfactorily assigned?

Materials and methods

We obtained photographic material of Buff-bellied Penduline Tits through correspondence and from prominent internet-based bio-inventory and image databases including iNaturalist, the Macaulay Library, Flickr and the African Bird Club. Specimen photographs, including of the type specimens of *sylviella*, *sharpei* and *rothschildi* were obtained courtesy of curatorial staff at several museums (see Appendix A and Acknowledgements), as well as from the Global Biodiversity Information Facility. Images were imported into Corel Draw to produce composite figures. Geo-referenced observation data from Tanzania (Baker & Baker 2020) was also used to define range limits more clearly, while lists of media reviewed and locations with coordinates are provided in Appendices A and B respectively.

Results

In East Africa, we recognize three subspecies in the Buff-bellied Penduline Tit grouping of *A. caroli* as well as intergrades in two areas as follows. Distributions and the locations of field photographs and specimen photographs reviewed are shown in Figure 2.

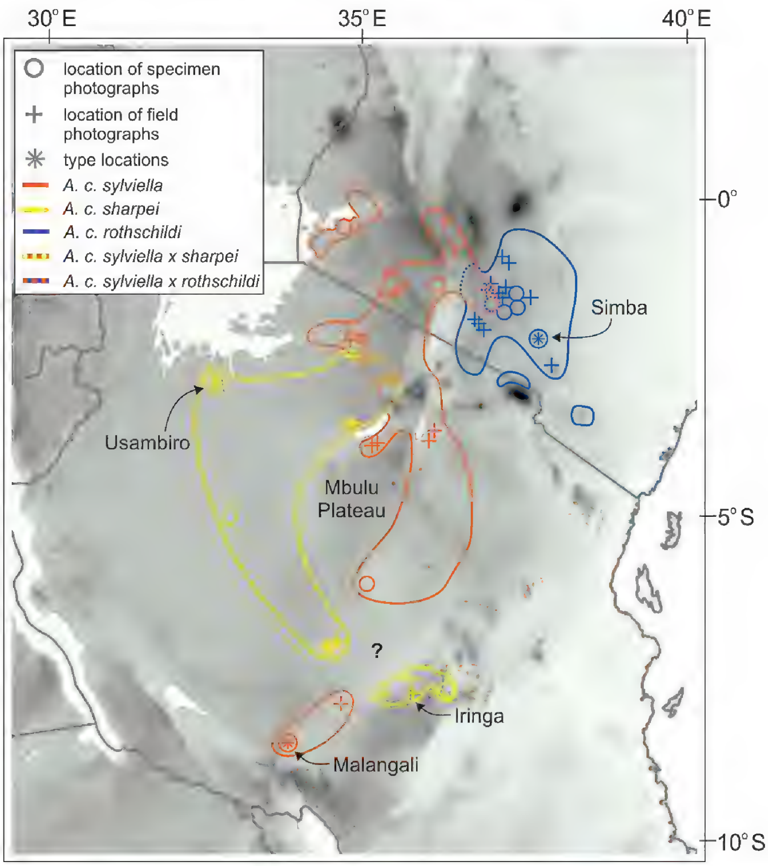

Figure 2. Map showing the approximate range limits of the buff-bellied subspecies of the Grey Penduline Tit *Anthoscopus caroli sylviella, A. c. sharpei* and *A. c. rothschildi* (and intergrades) in East Africa, as well as type localities and the locations of birds examined from field photographs or specimen photographs.

A. c. sylviella Reichenow (n = five specimens and 18 birds in field photographs). **Appearance**: a distinctive form marked by **rusty-clay underparts** which are darker than those of *A. c. sharpei,* contrary to all literature accounts which state that *sharpei* shows darker underparts (see Discussion). The throat, cheeks and forehead are largely concolorous with the lower underparts, or occasionally very marginally paler (Fig. 3A-C, Fig. 4A-D). The **upperparts are dark grey, lightly washed olive-brown**, and again darker than in *sharpei.* Wing: 55 mm. **Habitat**: in semi-arid to moist ***Acacia*-dominated savannah grasslands** (notably ***A. tortilis*** and ***A. gerardii***) from 800 to 2000 m in areas with approximately 500–1000 mm of annual rainfall. **Range**: southern and eastern Tanzania from "Malangali in Usafua" (type locality) northwards; disjunctly to Dodoma and Kikuyo, and from the Tarangire NP and the Yaida Valley, crossing the Rift Valley westwards into the Serengeti NP and north from there to the Mara GR, Kendu Bay and [rarely] Kisumu, east to the Loita Hills and the Athi River area (where it intergrades with *A. c. rothschildi* (see below)). Birds in the central Kenya Rift Valley from Gilgil to Nakuru may also belong here, as could birds reported from Lake Jipe, none of which have been collected or documented by photographs.

A. c. sharpei Hartert (n = three specimens and nine birds in field photographs). **Appearance**: a less well marked but still recognizable form that intergrades with the previous taxon where the two of them meet along the southern edges of Serengeti NP (see below). It differs from *sylviella* in its paler **tawny-orange mid- and lower underparts** (vs rusty-clay) and **with clear contrast from tawny breast to pale greyish-buff throat, cheeks and forehead,** these latter areas sometimes taking on a frosty appearance (Fig. 3D-F, Fig. 4E-H). **The upperparts, meanwhile, are paler grey and lack the olive-brown wash of *sylviella*.** A minor cline in underpart tone appears to exist from west to east, birds in the former regions (Usambiro–Tabora) being marginally richer than the latter (Ruaha NP–Iringa). Wing: 54–59 mm. **Habitat**: primarily in semi-arid ***Acacia*-dominated bushy woodlands** (notably ***A. albida*** and ***A. gerardii***) from 1100 to 1700 m in areas with approximately 600 to 1100 mm of annual rainfall. Unlike the previous taxon, however, *sharpei* also inhabits mixed semi-deciduous and *Brachystegia* woodlands, and in some regions, such as the Iringa-Dabaga area, woodland with almost no *Acacia*, may be used. **Range**: endemic to Tanzania from Usambiro (type locality), Maswa GR and the southern Serengeti NP south to the Tabora region and southeast from there to Rungwa GR, Ruaha NP and Iringa District.

A. c. rothschildi Neumann: (n = four specimens and 12 birds in field photographs). **Appearance**: a very distinctive form marked by the absence of any rusty or tawny tones to the **underparts which are a smooth cream-buff**, appearing pale yellow under soft light. Unlike the previous two forms, **the cheeks and forehead are a richer colour than the underparts**; a dull golden-beeswax tone (Fig. 3G-H, Fig. 4I-L). **The upperparts are a paler and more lavender-grey than in *sylviella*** and not dissimilar to the upperparts of *sharpei.* Wing: 51.5 mm. **Habitat**: favours semi-humid **mixed *Acacia* and broadleaf woodland in hilly terrain** (notably ***A. mellifera*** *and* ***Erythrina abyssinica***) from 1000 to 1800 m in areas with approximately 500 to 1100 mm of annual rainfall. **Range**: near-endemic to central-east Kenya from Thika, Embu and Kitui Districts south to Athi River, Machakos, Kajiado, Simba (type locality) and the Chyulu Hills, towards disjunct populations in southern Kenya near Oloitokitok, and [rarely] northern Tanzania in Loliondo District. Pale and rather nondescript birds reported from the Taita Hills, area below the known altitudinal range of *rothschildi*, may be that form, or may possibly be referable to *A. c. taruensis* (= *A. c. robertsi*).

A. c. sylviella* x *sharpei intergrade (n = no specimens and three birds in field photographs). **Appearance**: variably appearing birds show a combination of the characteristics of the two forms. Some birds show rich clay-toned underparts (including throat, cheeks and forehead) as in *sylviella*, but with paler silvery grey upperparts as in *sharpei* (Fig. 5A), while other birds show rich clay-toned underparts as in *sylviella* but with contrastingly paler, light buffy-grey cheeks and forehead as in *sharpei* (Fig. 5B) **Habitat**: primarily found in mixed *Acacia* woodland at 1400–1700 m. **Range**: birds occurring from the northern end of the Lake Eyasi and Olduvai Gorge area west through the southern parts of the Serengeti NP to the Grumeti River area appear to show the most variation.

A. c. sylviella* x *rothschildi intergrade (n = one specimen and one bird in field photographs). **Appearance**: birds show warmer buff underparts approaching those of *sylviella* (with some tawny tones) than the typical pale cream tones of *rothschildi* but with the cheeks and forehead concolorous with the lower underparts unlike the contrastingly richer tones of these parts in *rothschildi* (Fig. 6). **Habitat**: found in the drier parts of the range of *rothschildi*, where inhabits riparian *Acacia* woodlands at 1400–1500 m. **Range**: Athi River to Machakos, in east-central Kenya.

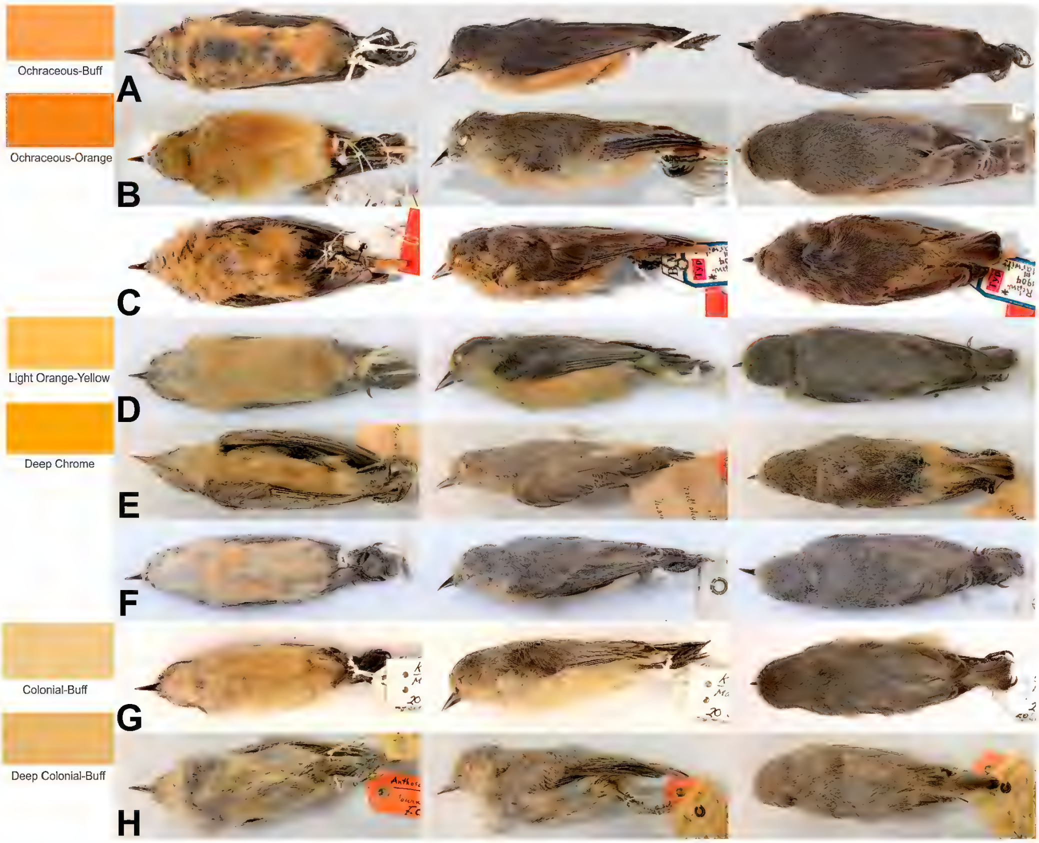

Figure 3. Comparative specimen material of *Anthoscopus caroli* representing the three taxa of the Buff-bellied Penduline Tit grouping: *A. c. sylviella* from Dodoma (A), the Loita Hills (B) and Malangali (C; holotype) in Tanzania and Kenya, *A. c. sharpei* from Tabora (D), Usambiro (E; holotype) and Iringa District (F) in Tanzania, and *A. c. rothschildi* from Machakos (G), and Simba (H; holotype) in Kenya. Comparative colour inserts (Ridway 1912) show the range of underpart tones for each taxon.

Figure 4. Comparative field photographs of *Anthoscopus caroli* representing the three taxa of the Buff-bellied Penduline Tit grouping: *A. c. sylviella* from Ruaha NP at Jongomero (A; R. Glenn), the Yaida Valley (B; D. Peterson), Serengeti NP (C; J. Mittermeier) and Masai Mara GR (D; A. Scott-Kennedy), *A. c. sharpei* from Iringa (E; T. Gwilliams), Rungwa GR (F; T. Chansac), Serengeti NP (G; G. Douglas) and Maswa GR (H; P. Oliver), and *A. c. rothschildi* from Athi River (I; B. Finch), Thika (J; E. Wolfer), Kajiado (K; P. Wairasho) and Machakos (L; J. Kashangaki). Comparative colour inserts (Ridway 1912) show the range of underpart tones for each taxon.

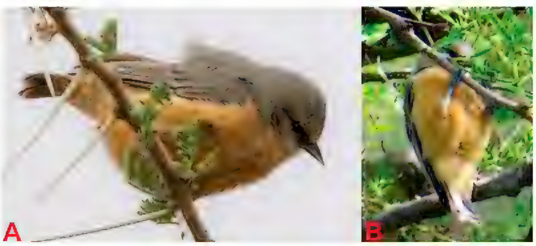

Figure 5. Field photographs of presumed intergrade *Anthscopus caroli sylviella x sharpei* from Olduvai Gorge (A; C. Artuso) and Serengeti NP (B; G. Johnson) in Tanzania.

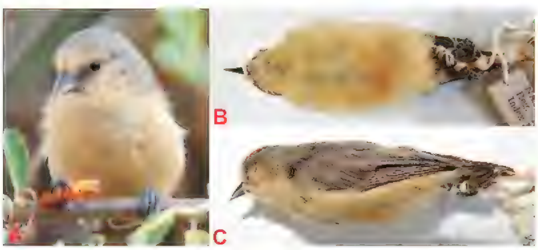

Figure 6. Specimen photographs of presumed intergrade *Anthoscopus c. sylviella x rothschildi* from Athi River (A; J. Linner) and Machakos (B-C) in Kenya.

Atypical birds

We also draw attention here to a bird photographed in the Chyulu Hills, Kenya (Fig. 7), which appears slightly different from typical *A. c. rothschildi* that might be expected to occur here. The image shows a small bird with a rich buff forehead patch, as in *rothschildi*, but the cream-buff of the underparts is more centrally restricted with the

flanks, and the undertail coverts snowy-white. These features fit no described taxon precisely and this individual could be an example of an aberrant *A. c. rothschildi*. We highlight it here, however, as several other unique taxa are known to have evolved on the Chyulu Hills, parts of which are still comparatively poorly known.

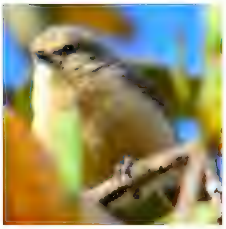

Figure 7. Photograph of *Anthoscopus caroli* taken in the Chyulu Hills, KE (S. Dolrenry), showing a bird which is most similar to the form *rothschildi*, but which differs from typical individuals in its two-toned underparts, resulting from the flanks and undertail coverts being snowy white and not buff.

Discussion

Taxa sylviella and sharpei

A review of field photographs and photographs of specimen material shows that *sylviella* and *sharpei* each comprise recognizable taxa. However, contrary to the prevailing sources (e.g., Harrap & Quinn 1995, Fry *et al.* 2000) that comment on the differences between *sylviella* and *sharpei*, it is *sylviella*, not *sharpei,* that shows darker rusty-clay underparts, which in the latter are paler and more tawny (more yellow, less red pigment). Furthermore, unlike the more silvery-grey upperparts of *sharpei* (and *rothschildi*), *sylviella* also shows an olive-brown cast to its grey upperparts resulting in a darker appearance than *sharpei*. Descriptions by Mackworth-Praed & Grant (1960) also state that the forehead of *sylviella* is pale buff vs a richer tawny in *sharpei*, when in fact, the opposite is the case.

These contradictions are difficult to explain but it seems possible that they may be related to the incorrect referral of specimens from Iringa to *sylviella* by Lynes (1934), who compared his material from Iringa with only the type specimen of *sylviella* but not with that of *sharpei*. Given the buff underparts of both forms, a referral to *sylviella* without review of the type material of *sharpei* would be quite understandable. Moreover, the debate at the time as to whether *sharpei* was actually a recognizable subspecies (see Introduction) may have prompted Lynes to refer Iringa birds to *sylviella* in the absence of any other widely accepted "buff-bellied" form. While Lynes's four specimens could not be traced for this study, our specimen images and field photographs from Iringa District show a bird with pale underpart tones and silvery-grey upperparts matching most closely with the type specimen of *sharpei* from Usambiro, the *sharpei* specimen from Tabora, as well as that from the Dabaga area immediately east of Iringa. The distribution of *sharpei* has hitherto not been known to extend southeast from Usambiro beyond Tabora, while the finding that *sharpei* and *sylviella* occur within close proximity of each other in the Ruaha NP–Iringa area of south-central Tanzania is also novel.

Meanwhile, it seems possible that on examining birds with richly coloured underparts from southwest Kenya, Mackworth-Praed & Grant (1960) incorrectly treated these as *sharpei* on the basis of closer proximity to the type locality of that taxon at Usambiro, and on the basis of Lynes's specimens with pale underparts from Iringa which had been incorrectly referred to *sylviella*. In fact, birds in Iringa resemble *sharpei* more closely despite some proximity to "Malangali in Usafua" (type locality of *sylviella*), while birds in southwest Kenya (and most of the Serengeti NP) resemble *sylviella* more closely, despite their proximity to Usambiro (type locality of *sharpei*).

Taxon rothschildi

Our study also confirms the presence of a third distinct form of the Buff-bellied Penduline Tit group of *A. caroli* in East Africa, in addition to the subspecies *sylviella* and *sharpei*, currently recognized (Dickinson & Christidis 2014, Clements *et al.* 2019, Gill & Donsker 2020). Taxon *rothschildi* is no less distinctive than *sylviella* or *sharpei* and should be recognized as the form occurring east of the Rift Valley in Kenya. The reasons for White's (1963) decision to synonymize *rothschildi* with *sylviella* are unclear. However, the misconception that birds east and west of the Rift Valley in Tanzania comprised paler *sylviella* and richer *sharpei* respectively (see above), may have clouded the situation in Kenya. Such a misunderstanding, that east of the Rift Valley in Tanzania the form *sylviella* comprised a paler version of *sharpei* to the west of the Rift Valley, may simply have been applied across the same geographic break in Kenya where *rothschildi* to the east of the Rift Valley is paler than *sylviella* to the west of the Rift Valley. Hypothetically, and in the possible absence of adequate specimen material, this could have led, incorrectly, to the synonymy of *rothschildi* with *sylviella* by White (1963).

Therefore, the progressive discrepancies in identification criteria in literature accounts appear to be possibly based on misconceptions that, firstly, birds in Iringa represented *sylviella* (rather than *sharpei*), secondly, that birds in southwest Kenya represented *sharpei* (rather than *sylviella*), and lastly, that birds in eastern Kenya represented *sylviella* (rather than *rothschildi*). Our detailed review presented here, disputes all of these previously understood literature accounts. Both specimen evidence and field photographs show that *rothschildi* differs from *sylviella* to a considerable degree, and that *sharpei* shows an underpart tone somewhat intermediate between the two.

Intergrades and atypical birds

The forms *sylviella* and *sharpei* taxa appear to intergrade in the southern parts of the Serengeti NP, where gaps in the Rift Valley in the vicinity of Lake Eyasi and Ngorongoro Crater have permitted a westerly intrusion of *sylviella* into north-central Tanzania and southeast Kenya, both areas to the west of the Rift Valley. To the south of here, however, where distance between the populations is maintained by the high and largely unsuitable woodlands of the Mbulu Highlands, the two taxa assume distinct appearances as is shown by the type material and additional specimens. It is unclear whether the two forms meet anywhere in eastern parts of Ruaha NP to the Iringa area (designated by a "?" in Figure 2) but it seems possible that subtle differences in ecological preferences (e.g., altitude and/or rainfall regimes) may keep them separated.

Much as *sylviella* intergrades with *sharpei* across a portion of the southern Serengeti, it also appears to intergrade with *rothschildi* across a small area of central-east Kenya. This is permitted by way of only limited barriers to the movement of birds representative of each form in intervening areas that would otherwise separate distributions. *A. c. rothschildi*, meanwhile, is separated at the southern end of its range from *sylviella* at its northern extremity, by an arid corridor extending westwards from the Somali–Masai steppe of eastern Kenya and Tanzania to Lake Natron, which is occupied by Mouse-coloured Penduline Tit *A. musculus*.

Lastly, birds in the Chyulu Hills may merit further study. The few photographs reviewed from this area reveal a form that we treat here as *rothschildi* but with some reservations (Fig. 7). A distinct two-toned quality to the underparts is inconsistent with *rothschildi* and this range of hills is known for supporting several divergent forms, some regarded as separate subspecies (e.g., see Gill *et al.* 2020).

Conclusions

Our study presented here has clarified the field characters and corrected a number of misconceptions and oversights regarding the taxonomy of the Buff-bellied Penduline Tit subspecies of *A. caroli* in East Africa, and we propose a revised treatment for this complex following an integrated assessment of specimen and field evidence. We clarify the field characters for *sharpei* and *sylviella* and confirm each as recognizable taxa that, while apparently remaining separated in the southern reaches of their ranges, intergrade where they meet in the north of it in the vicinity of the southern Serengeti NP. Similarly, we also clarify field characters for, and recognize *rothschildi* of eastern Kenya, where birds have been incorrectly treated as *sylviella* for more than half a century. We document a narrow zone of intergrading with *sylviella* near Nairobi, for these otherwise distinct forms. Lastly, we highlight atypical birds in the Chyulu Hills suggesting an avenue for further study. Further work on this complex should focus on the genetic relatedness between these three taxa, and the extent to which they differ in all respects from other forms within the Grey Penduline Tit.

Acknowledgements

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Appendix A. Field and Specimen Material

Taxon	Location	Media	Photographer	This paper	Reference
A. c. sylviella	Dodoma (Kikuyo), TZ	specimen	NA	Fig. 3A	NHMD #075650, Fjeldså 2015
A. c. sylviella	Loita Hills, KE	specimen	Sidney Shema	Fig. 3B	NMK #18493/18226
A. c. sylviella	Kendu Bay, KE	specimen	Sean Lyon		FMNH #199060
A. c. sylviella	Kendu Bay, KE	specimen	Sean Lyon		FMNH #199059
A. c. sylviella (holotype)	Malangali, TZ	specimen	Sylke Frahnert	Fig. 3C	ZMB #48/68
A. c. sharpei	Tabora (Kazima), TZ	specimen	Robert Faucett	Fig. 3D	UWBM #95720 (MBM 5909)
A. c. sharpei (holotype)	Usambiro, TZ	specimen	Paul Sweet	Fig. 3E	AMNH #683337
A. c. sharpei	Dabaga, Iringa Dist., TZ	specimen	Sean Lyon	Fig. 3F	FMNH #216940
A. c. rothschildi	Machakos, KE	specimen	Brett Benz	Fig. 3G	UMMZ #208864
A. c. rothschildi	Machakos, KE	specimen	Sidney Shema		NMK #18490/13758
A. c. rothschildi	Athi River, KE	specimen	Sidney Shema		NMK #18498/13755
A. c. rothschildi (holotype)	Simba, KE	specimen	Paul Sweet	Fig. 3H	AMNH #683335
A. c. sylviella x rothschildi	Machakos, KE	specimen	Sidney Shema	Fig. 6B-C	NMK #18488/13757
A. c. sylviella	Ruaha NP (Jongomero), TZ	field image	Rob Glenn	Fig. 4A	Pers. comm.
A. c. sylviella	Tarangire NP, TZ	field image	Neil Bachmann		www.flickr.com
A. c. sylviella	Tarangire NP, TZ	field image	Lara Tranter		www.tanzaniabirds.net
A. c. sylviella	Tarangire NP, TZ	field image	Markus Lilje		iNat #81332093
A. c. sylviella	Yaida Valley, TZ	field image	Daudi Peterson	Fig. 4B	Pers. comm.
A. c. sylviella	Yaida Valley, TZ	field image	Daudi Peterson		Pers. comm.
A. c. sylviella	Loita Hills, KE	field image	Nik Borrow		Pers. comm.
A. c. sylviella	Maasai Mara GR, KE	field image	Adam Scott-Kennedy	Fig. 4D	Pers. comm.
A. c. sylviella	Maasai Mara GR, KE	field image	Stratton Hatfield		ML #160466171
A. c. sylviella	Maasai Mara GR, KE	field image	Stratton Hatfield		Pers. comm.
A. c. sylviella	Maasai Mara GR, KE	field image	Jenny Bowman		ML #210904891
A. c. sylviella	Serengeti NP, TZ	field image	Dan Borman		ML #250765021
A. c. sylviella	Serengeti NP, TZ	field image	Bradley Hacker		ML #302702841
A. c. sylviella	Serengeti NP (Singita), TZ	field image	Gary Douglas		ML # 253671341

Taxon	Location	Media	Photographer	This paper	Reference
A. c. sylviella	Serengeti NP (Singita), TZ	field image	John Mittermeier	Fig. 4C	ML #246824341
A. c. sylviella	Serengeti NP (Seronera), TZ	field image	Markus Lilje		iNat #6484936
A. c. sylviella (juvenile)	Serengeti NP (Mbalagati), TZ	field image	Brian Lawrence		www.flickr.com
A. c. sylviella (juvenile)	Serengeti NP (Singita), TZ	field image	Gary Douglas		ML #168291091
A. c. sylviella x sharpei	Olduvai Gorge, TZ	field image	Christian Artuso	Fig. 5A	iNat #33286813
A. c. sylviella x sharpei	Serengeti NP, TZ	field image	Sheau Torng Lim		www.flickr.com
A. c. sylviella x sharpei	Serengeti NP, TZ	field image	Greg Johnson	Fig. 5B	www.flickr.com
A. c. sharpei	Iringa, TZ	field image	Tommy Gwilliams	Fig. 4E	Pers. comm.
A. c. sharpei	Nduli, Iringa, TZ	field image	Neil Baker		NA
A. c. sharpei	Rungwa GR, TZ	field image	Thibaut Chansac	Fig. 4F	NA
A. c. sharpei	Rungwa GR, TZ	field image	Thibaut Chansac		NA
A. c. sharpei	Rungwa GR, TZ	field image	Thibaut Chansac		NA
A. c. sharpei	Maswa GR, TZ	field image	Paul Oliver		Pers. comm.
A. c. sharpei	Maswa GR, TZ	field image	Paul Oliver	Fig. 4H	Pers. comm.
A. c. sharpei	Serengeti NP, TZ	field image	Gary Douglas	Fig. 4G	ML # 351513171
A. c. sharpei	Serengeti NP, TZ	field image	Alastair Kilpin		Pers. comm.
A. c. rothschildi	Machakos (Lukenya), KE	field image	Peter Steward		Pers. comm.
A. c. rothschildi	Machakos (Lukenya), KE	field image	Brian Finch	Fig. 4I	NA
A. c. rothschildi	Machakos (Maanzoni), KE	field image	Mark Bullough		Pers. comm.
A. c. rothschildi	Machakos (Mutetheni), KE	field image	James Kashangaki	Fig. 4L	ML #206082611
A. c. rothschildi	Nairobi NP, KE	field image	Brian Finch		NA
A. c. rothschildi	Thika, KE	field image	Elvira Wolfer	Fig. 4J	Pers. comm.
A. c. rothschildi	Thika, KE	field image	Elvira Wolfer		Pers. comm.
A. c. rothschildi	Kajiado, KE	field image	Peter Wairasho	Fig. 4K	Pers. comm.
A. c. rothschildi	Kajiado, KE	field image	Peter Wairasho		Pers. comm.
A. c. rothschildi	Kajiado, KE	field image	Martin Mwangi		Pers. comm.
A. c. rothschildi	Chyulu Hills, KE	field image	Stephanie Dolrenry	Fig. 7	ML #114838911 & #114838501
A. c. rothschildi (juvenile)	Thika, KE	field image	James Bradley		ML #48817121
A. c. sylviella x rothschildi	Athi River, KE	field image	Jan Linner	Fig. 6; A	ML #48387551 & #48387571

Appendix B. Gazetteer

Locations in Kenya	Latitude	Longitude	Locations in Tanzania	Latitude	Longitude
Athi River	1°26'6"S	36°59'48"E	Dabaga (foothills)	8°2'19"S	35°50'56"E
Chyulu Hills	2°34'4"S	37°49'12"E	Iringa	7°47'11"S	35°42'14"E
Embu	0°32'53"S	37°27'36"E	Kikuyo, Dodoma	5°52'42"S	35°4'18"E
Fort Hall (Muranga)	0°43'52"S	37°9'28"E	Longido	2°43'35"S	36°42'57"E
Kajiado	1°51'16"S	36°47'13"E	Malangali in Usafua	8°25'00"S	33°50'00"E
Kendu Bay	0°22'29"S	34°39'3"E	Maswa GR	3°31'26"S	34°40'53"E
Kitui District	1°21'14"S	38°1'26"E	Nduli, Iringa	7°38'5"S	35°45'12"E
Lake Elementaita	0°24'33"S	36°12'41"E	Olduvai Gorge	2°59'50"S	35°20'28"E
Lake Nakuru NP	0°25'36"S	36°6'13"E	Ruaha NP	7°41'48"S	34°57'10"E
Lambwe Valley	0°38'33"S	34°16'13"E	Rungwa GR	6°50'32"S	34°16'38"E
Loita Hills	1°22'8"S	35°44'14"E	Serengeti NP (Seronera)	2°26'34"S	34°48'18"E
Maasai Mara GR	1°28'45"S	35°14'14"E	Serengeti NP (Singita)	2°4'43"S	34°29'28"E
Machakos	1°31'42"S	37°16'23"E	Serengeti NP (Sopa)	2°35'46"S	34°40'41"E
Machakos (Lukenya)	1°29'3"S	37°4'45"E	Tabora (Kazima)	4°59'49"S	32°54'15"E
Machakos (Maanzoni)	1°29'25"S	37°7'49"E	Tarangire NP	3°55'47"S	36°1'25"E
Machakos (Mutetheni)	1°30'5"S	37°31'0"E	Usambiro	3°05'00"S	32°40'00"E
Simba	2°9'26"S	37°35'26"E	Yaida Valley	4°0'32"S	34°59'25"E
Taita Hills	3°25'52"S	38°24'50"E			
Thika	1°1'44"S	37°4'18"E			
Voi	3°24'15"S	38°33'12"E			

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Further surveys of the miombo woodland avifaunas of Mbarang'andu and Kimbanda Wildlife Management Areas, southern Tanzania

Chacha Werema and Cuthbert L. Nahonyo

Summary

Wildlife Management Areas (WMAs) have been thought as being a sustainable model that can promote wildlife conservation while improving the livelihoods of rural communities. Some WMAs in Tanzania have been found to be species-rich with abundant wildlife communities. Such WMAs include Mbarang'andu and Kimbanda WMAs in southern Tanzania which together with Nalika, Chingoli and Kisungule WMAs form a wildlife corridor that connects Nyerere National Park in Tanzania and Niassa Special Reserve in Mozambique. While the mammalian fauna of the Ruvuma landscape is well documented, the avifauna is comparatively poorly known. From 122 1-km transects, this study reports on the bird species found in miombo woodlands in Mbarang'andu and Kimbanda WMAs. One hundred and fifty-six species were observed of which two are globally threatened and 20 were biome-restricted, suggesting that the miombo woodlands in Mbarang'andu and Kimbanda WMAs are important for the conservation of birds in southern Tanzania. We recommend that further avifaunal surveys focus on less sampled areas in our study, including riverine forests and swampy habitats.

Keywords: birds, Tanzania, conservation, miombo woodlands, Wildlife Management Area

Introduction

Wildlife Management Areas (WMAs) are community-based conservation and development areas where several villages set aside land for wildlife conservation in return for some of the tourism revenues from these areas (URT 2012). The local people in these villages have user rights over the wildlife resources in their WMAs, and WMAs have been considered as models with a dual stratergy: to alleviate poverty and to halt overall biodiversity declines (Berkes 2004, Kiss 2004). Thus, WMAs function as a conservation tool and can also be considered as a model to improve livelihoods in rural communities (Kiffner *et al.* 2020). Establishing WMAs is a way of decentralizing wildlife management to the local communities (Lee & Bond 2018) and, as such, natural resource conservation in these WMAs is principally a shared responsibility and local communities must significantly benefit from it (Stolla 2005, URT 2009).

Mbarang'andu and Kimbanda WMAs are part of the extensive miombo woodland system of eastern and southern Africa. The two WMAs form part of the Selous-Niassa wildlife corridor which has been viewed as both an internationally important

wildlife conservation area, and as a biologically important corridor. For example, this corridor is inhabited by globally significant populations of eland *Taurotragus oryx*, Lichtenstein's hartebeest *Alcelaphus buselaphus lichtensteinii*, greater kudu *Tragelaphus strepsiceros*, Roosevelt's sable antelope *Hippotragus niger roosevelti*, and Nyassa wildebeest *Connochaetes taurinus johnstoni* and other wildlife and plantlife (Hofer *et al.* 2004). Thus, the two WMAs occupy an intriguing position biogeographically, and help to maintain connectivity within the formerly unprotected Selous-Niassa wildlife corridor. This is an important transboundary corridor which provides complementary conservation roles which cannot be achieved by the current national parks and game reserves networks alone (Caro *et al.* 2009).

A number of authors have provided broad distributions for birds in this part of Tanzania, including Mackworth-Praed & Grant (1960), Britton (1980), Brown *et al.* (1982), Urban *et al.* (1986, 1997), Fry *et al.* (1988, 2000), Keith *et al.* (1992), Fry & Keith (2004) and Stevenson & Fanshawe (2020). Also, in the Ruvuma landscape (including Mbarang'andu and Kimbanda WMAs), Nkwabi *et al.* (2021) surveyed birds in five different habitats, namely, dense woodland, open woodland, riverine forest, swampy areas and farmlands. However, Nkwabi *et al.* (2021) covered only a small proportion of the existing woodlands, hence there is a need for additional avifaunal surveys. This is important for monitoring purposes, because the existing vegetation cover in the miombo woodlands of the WMAs may change over time due to land use changes as well as habitat fragmentation caused by human activities which include uncontrolled wildfires, collection of fuel wood, charcoal production, tree-felling for timber, cattle grazing and agriculture (Nkwabi *et al.* 2021).

Materials and methods

Study area

Mbarang'andu WMA (2318 km^2; gazetted in 2006) and Kimbanda WMA (2150 km^2; gazetted in 2012) are located in Namtumbo District, Ruvuma Region, southern Tanzania (WWF 2014; Fig. 1). To the east, the Mbarang'andu and Kimbanda WMAs are bordered by Nalika, Chingoli and Kisungule WMAs. Together, these five WMAs comprise the Selous-Niassa Corridor. The area receives an average rainfall of 800–1100 mm per year which falls during a single period from late November to May (Hofer *et al.* 2004).

The landscape where the two WMAs are located consists of plains, valleys, and hills in an undulating topography. The area is mostly covered by miombo woodland and wooded grassland, and there are substantial areas of open savannah, seasonal and permanent wetlands and riverine forests along numerous rivers and streams. The miombo trees are of the Caesalpiniaceae family. The trees in this family were dominated by members of the genera *Brachystegia* and *Julbernardia*. Eight *Brachystegia* species have been identified including *Brachystegia boehmii*, *B. bussei*, *B. floribunda*, *B. longifolia*, *B. microphylla*, *B. spiciformis*, *B. tipulate* and *B. utilis* (Hofer *et al.* 2004). Other tree species include *Pseudolachnostylis maprouneifolia*, *Diplorhynchus condylocarpon*, *Dalbergia nitidula*, *Monotes katangensis*, *Terminalia sericea*, *Uapaca nitida*, *U. kirkiana* and *U. sansibarica*.

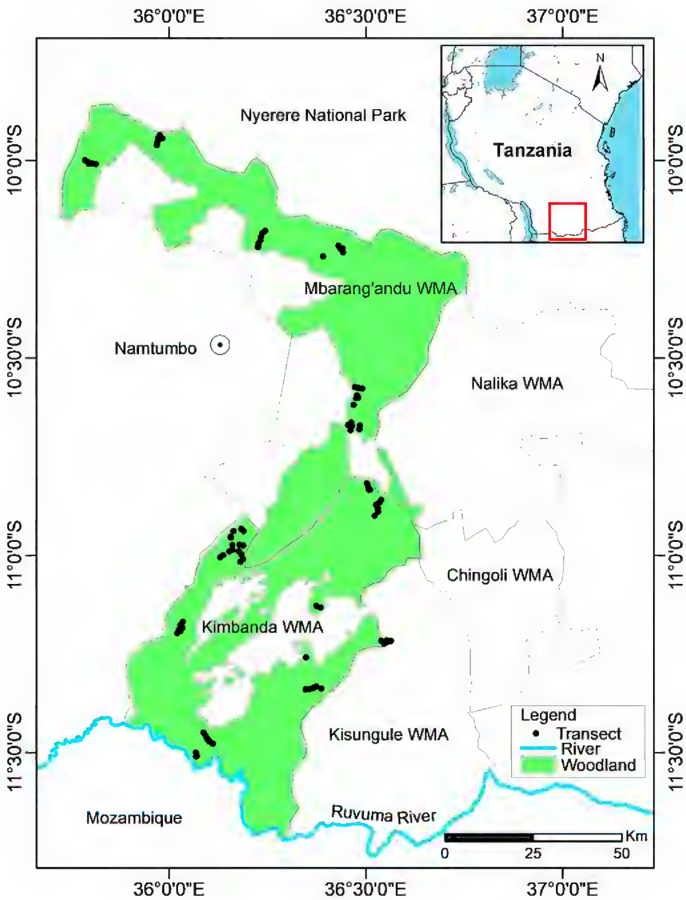

Figure 1. Map of Mbaran'gandu and Kimbanda WMAs showing the locations of transects. Coverage of the woodlands which were set aside by villages forming the two WMAs for conservation are shown in green. Note that Ruvuma River is the border between Tanzania and Mozambique.

Data collection and analysis

Birds were surveyed using the transect method (Bibby *et al.* 2000) and we concentrated our sampling effort on closed-canopy miombo woodland and strips of evergreen riverine forest within these woodlands (Fig. 1). In total, 122 transects were surveyed (62 in Mbarang'andu WMA and 60 in Kimbanda WMA; see Fig. 1 for the location of transects). The total length of transect surveyed was 122 km, an area equivalent to 12.2 km^2. Pre-selected starting points were established for each transect to ensure that coverage of the miombo woodlands in the WMAs was representative and spatially balanced. Transects were accessed through available road networks and trails. Each transect was sampled once and GPS units were used to ensure that our field surveys closely followed transect routes selected beforehand.

The habitats on most of the transects were homogenous and the orientation of each transect varied. Field surveys were conducted from 26 May to 7 June 2021 and from 12 to 27 January 2022 and bird observations started in the early morning (usually at 07:00). For logistical reasons, transects were surveyed throughout the day. Bird

species and numbers were recorded within 50 m of each side of the transect, and for species which were not directly identified in the field, brief notes describing them, or their vocalizations, were recorded to allow for later identification. Birds flying overhead were included if they were specifically associated with the habitat (e.g., swallows and birds of prey actively foraging along the transects).

To assess whether sampling effort was adequate, a sample-based rarefaction curve was generated using the program Paleontological Statistics software–PAST (Hammer *et al.* 2001). To have the percentage of the predicted species, Chao2 species richness estimator was used to estimate species richness (by a set of samples), which has been shown to perform well for bird communities (Walther & Martin 2001). This was produced with the PAST software (Hammer *et al.* 2001). For each species, in every WMA, species occurrence was expressed in terms of its relative frequency (*Rf*) (i.e., as a proportion of the number of transects in which a species was observed: n = 62 for Mbarang'andu WMA and n = 60 for Kimbanda WMA) on the basis of its presence or absence in the transects. *Rf* comprises an index of bird abundance and allowed for a general assessment of the abundance of different species in the WMAs; the higher the *Rf* of the species, the more widely distributed it is in the study area.

Taxonomy and nomenclature follow the IOC world bird list (see Gill *et al.* 2021) except for the following species where we use differing nomenclature: Common Bulbul *Pycnonotus barbatus* was regarded as Dark-capped Bulbul *P. tricolor*, Rufous-bellied Tit *Parus rufiventris* as Cinnamon-breasted Tit *Melaniparus pallidiventris*, Miombo Wren-Warbler *Calamonastes undosus* as Stierling's Wren-Warbler *Calamonastes stierlingi,* African Yellow White-eye *Zosterops senegalensis* as Southern Yellow White-eye *Z. anderssoni* and Spotted Creeper *Salpornis slavadori* as African Spotted Creeper *S. salvadori.*

Results

We recorded a total of 156 species (3487 individuals) of which 92 were observed in both Mbarang'andu and Kimbanda WMAs (Appendix 1). Of the 156 species observed, 111 (1277 individuals) and 137 (2210 individuals) were recorded in Mbarang'andu and Kimbanda WMAs, respectively (Appendix 1). The species accumulation curve approached asymptote suggesting that few species were likely to be recorded on additional transects in the woodlands (Fig. 2). An analysis by Chao2 species richness estimator, showed that we recorded 89% of the expected 175 (s.d. ± 9.12) species that would be recorded from an exhaustive survey.

The most frequently recorded species include Pale Batis *Batis soror* (*Rf* in the two WMAs combined = 51; i.e. 51 out of 122 transects), Yellow-throated Bush-Sparrow *Gymnoris superciliaris* (46/122), Black-crowned Tchagra *Tchagra senegalus* (44/122), Black-backed Puffback *Dryoscopus cubla* (43/122) and Western Violet-backed Sunbird *Anthreptes longuemarei* (41/122) (Appendix 1). The most abundant species were Orange-breasted Waxbill *Amandava subflava* (180 individuals), Yellow-throated Bush-Sparrow (165), White-crested Helmetshrike *Prionops plumatus* (152), Pale Batis (140) and Violet-backed Starling *Cinnyricinclus leucogaster* (121) (Appendix 1).

Twenty-two forest-dependent species were observed in these woodlands, all of which were forest generalists (Bennun *et al.* 1996, Mlingwa *et al.* 2000; Appendix 1) including the African Broadbill *Smithornis capensis* which is considered a forest generalist in southern Tanzania (Neil Baker, pers. comm) and not a forest specialist *sensu* Bennun *et al.* (1996).

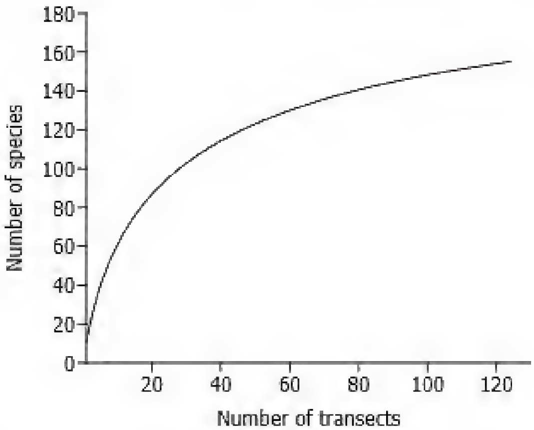

Figure 2. Bird species accumulation curve for transects surveyed in Mbarang'andu and Kimbanda WMAs.

Of the species observed, four and 12 species were Palaearctic and intra-African migrants, respectively (Appendix 1). The latter species are, variably, either breeding or non-breeding visitors to the area.

Twenty biome-restricted species were observed in the woodlands in the WMAs of which three species are restricted to the East African Coastal biome and 17 species that are Zambezian biome species (Table 1; Baker & Baker 2002). Furthermore, seven species recorded in the two WMAs have been regarded as endemic to *Brachystegia* (Benson & Irwin 1966). These are the Pale-billed Hornbill *Lophoceros pallidirostris*, Stierling's Woodpecker, Stierling's Wren-Warbler *Calamonastes stierlingi*, Böhm's Flycatcher *Muscicapa boehmi*, Miombo Rock Thrush *Monticola angolensis*, Shelley's Sunbird *Cinnyris shelleyi* and Black-eared Seed-eater *Crithagra mennelli.*

Table 1. Biome-restricted species (Baker & Baker 2002) recorded on transect surveys in Mbarang'andu and Kimbanda WMAs.

Biome	Species
	Brown-headed Parrot *Poicephalus cryptoxanthus*
East African Coast biome	Brown-breasted Barbet *Lybius melanopterus*
	Pale Batis *Batis soror*
	Pale-billed Hornbill *Lophoceros pallidirostris*
	Racket-tailed Roller *Coracias spatulatus*
	Böhm's Bee-eater *Merops boehmi*
	Stierling's Woodpecker *Dendropicos stierlingi*
	Dickinson's Kestrel *Falco dickinsoni*
	Cinnamon-breasted Tit *Melaniparus pallidiventris*
	Long-tailed Cisticola *Cisticola angusticauda*
	Stierling's Wren-Warbler *Calamonastes stierlingi*
Zambezian biome	Kurrichane Thrush *Turdus libonyana*
	Böhm's Flycatcher *Muscicapa boehmi*
	Miombo Rock Thrush *Monticola angolensis*
	Arnott's Chat *Myrmecocichla arnotti*
	Eastern Miombo Sunbird *Cinnyris manoensis*
	Shelley's Sunbird *Cinnyris shelleyi*
	Olive-headed Weaver *Ploceus olivaceiceps*
	Broad-tailed Paradise *Whydah Vidua obtusa*
	Black-eared Seed-eater *Crithagra mennelli*

Records of distributional interest

White-tailed Blue Flycatcher *Elminia albicauda*

We observed this species on four transects in Mbarang'andu WMA. There are also unpublished records held by the Tanzania Bird Atlas (http://tanzaniabirdatlas.net) from about 50 km to the northwest of the study area and records from that area are documented similarly by Urban *et al.* (1997).

Semicollared Flycatcher *Ficedula semitorquata*
Five males were observed on four transects in Mbarang'andu and Kimbanda WMAs. The species was identified based on the half-collar on the neck being more extensive than in the European Pied Flycatcher *F. hypoleuca*. This species is a Palaearctic migrant, and Urban *et al.* (1997) document the closest known range approximately 150 km to the northwest of the study area. Within the study area there is an unpublished record of this species held by the Tanzania Bird Atlas (http://tanzaniabirdatlas.net).

White-bellied Tit *Melaniparus albiventris*
Two single birds individuals were observed in two different feeding parties on two transects in Kimbanda WMA in January 2022. Fry *et al.* (2000) document the closest known population approximately 100 km to the north of the study area. However, there are some unpublished records held by the Tanzania Bird Atlas from our general study area (http://tanzaniabirdatlas.net).

Species of conservation concern
Two species of conservation concern were observed: Stierling's Woodpecker *Dendropicos stierlingi* and Olive-headed Weaver *Ploceus olivaceiceps* which are both Near-Threatened according to the IUCN RedList of Threatened Species (IUCN 2022). Stierling's Woodpecker was observed in 18 out of 122 transects in both Kimbanda and Mbarang'andu WMAs, usually in singles, which is an unexpectedly high density for this species (N. Baker pers. comm.). Meanwhile, we observed seven individuals of Olive-headed Weaver on four transects in Mbarang'andu WMA, where they (both pairs and single birds) were observed actively foraging in the high canopy.

Discussion

With 156 species recorded in the miombo woodlands, including *Brachystegia* endemic species (see Benson & Irwin 1966), this study further reinforces the recognition of the woodlands found in Mbarang'andu and Kimbanda WMAs as important habitats for the conservation of birds. Ninety-two species recorded in the current study were also reported by Nkwabi *et al.* (2021) who conducted avian surveys in Mbarang'andu, Kimbanda, Nalika, Chingoli and Kisungule WMAs in the Ruvuma landscape. In addition to the results presented by Nkwabi *et al.* (2021), the present study expands the list by adding 64 more species.

A number of species recorded in the two WMAs are widespread in distribution. For example, approximately 87% (135 out of 156) of the species recorded in these WMAs have been observed in the Katavi-Rukwa ecosystem, southwestern Tanzania (Engilis *et al.* 2009). Further to the east, 85 species observed have been reported in the woodlands in southeastern Tanzania (Tottrup *et al.* 2005) and 87 species by Wegner *et al.* (2009) in the coastal forests of Mtwara, southeastern Tanzania. Furthermore, 134 species occurring in the study area have been reported in Vwaza Marsh Wildlife Reserve in Malawi, southwest of the study area (Engel *et al.* 2012).

Of the species recorded, there were 17 Zambezian Biome restricted species out of a country total of 40 species (Fishpool & Evans 2001, Baker & Baker 2002). This demonstrates that Mbarang'andu and Kimbanda WMAs, despite being village lands, support a relatively high percentage of species in this biome. This number is slightly more than that of the former Selous Game Reserve (whose size has been reduced to form Nyerere National Park and the existing smaller Selous Game Reserve—Government of Tanzania 2019) with 14 Zambezian biome restricted species (Baker & Baker 2002) in the same ecosystem. All the 14 Zambezian biome restricted species found in Nyerere National Park were observed in Mbarang'andu and Kimbanda WMAs.

While most species were more or less equally abundant in each of the two WMAs, there were some species which were missing in one WMA in comparison with the other. However, for most species the abundances were not strikingly different. The Violet-backed Starling *Cinnyricinclus leucogaster* was abundant in Kimbanda WMA but none was observed in Mbarang'andu WMA. It was recorded only in Kimbanda WMAs in January 2022 and not in May–June 2021. This pattern could be explained by the fact that this species is known to have complex movements (Britton 1980) and most populations make partial migratory movements (Fry *et al.* 2000). The Eastern Miombo Sunbird *Cinnyris manoensis* was abundant in the woodlands in Mbarang'andu WMA but none was recorded in Kimbanda WMA. Our records of this species match well with the distribution shown by additional unpublished records from this general area (www http://tanzaniabirdatlas.net/TZmap_squarelists.html), as well as with other isolated populations found in southern Tanzania (Fry *et al.* 2000).

The presence of riverine forests and some closed *Brachystegia* woodlands at some sites possibly increased habitat diversity in the study area, supporting 22 forest-dependent bird species (Bennun *et al.* 1996). Similar findings have been reported by Wegner *et al.* (2009) who recorded forest-dependent bird species in small patches of dense *Brachystegia* woodland and riverine forest in southern Tanzania. To the northeast of the study area, similar to the findings of this study, Stjernstedt (1969) reported a number of forest birds in lush and dense *Brachystegia microphyllum* vegetation. Of the 22 forest-dependent species observed during the current study, 14 were also recorded by Nkwabi *et al.* (2021) in the Ruvuma landscape. Similar to the findings of this study, out of 14 forest-dependent species observed by Nkwabi *et al.* (2021), six were recorded solely in the riverine forest, while the rest were recorded both in the riverine forest and miombo woodlands.

Conclusion

Our findings highlight Mbarang'andu and Kimbanda WMAs to be of great conservation importance for the miombo avifauna. This is justified by the records of bird species endemic to the *Brachystegia* (Benson & Irwin 1966) biome-restricted species and forest-dependent species. Similarly, since the two WMAs are still village lands, the presence of two Near-Threatened species emphasizes their conservation importance. Despite the present study and the study by Nkwabi *et al.* (2021), the number of species recorded in the woodlands during this study is not likely to be complete. Due to the importance of the two WMAs and the entire landscape as a corridor connecting Nyerere National Park and Niassa Special Reserve, we encourage additional surveys in the miombo woodlands in these WMAs, and in the other three WMAs in the Selous-Niassa Corridor.

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Appendix 1. Number of transects in which a species was observed (relative frequency) of bird species observed in miombo woodlands in Mbarang'andu and Kimbanda WMAs. Shown in parentheses are the total number of individuals of each species recorded in the transects in each WMA. FF = forest specialists, F = forest generalists (Bennun et al. 1996, Mlingwa et al. 2000), n = number of transects. Sequence and nomenclature follow Gill et al. (2021). PM and IM indicate species which are Palaearctic and intra-African migrants, respectively.

Species	Relative frequency Mbarang'andu (n = 62)	Relative frequency Kimbanda (n = 60)
Helmeted Guineafowl *Numida meleagris*	0(0)	2(4)
Coqui Francolin *Peliperdix coqui*	2(8)	4(6)
Red-necked Spurfowl *Pternistis afer*	0(0)	4(12)
[F]Fiery-necked Nightjar *Caprimulgus pectoralis*	1(1)	0(0)
Square-tailed Nightjar *Caprimulgus fossii* IM	1(1)	4(4)
Pennant-winged Nightjar *Caprimulgus vexillarius*	0(0)	2(3)
Purple-crested Turaco *Gallirex porphyreolophus*	3(5)	7(7)
White-browed Coucal *Centropus superciliosus*	0(0)	2(3)
[F]Red-chested Cuckoo *Cuculus solitarius* IM	1(1)	2(2)
Red-eyed Dove *Streptopelia semitorquata*	8(10)	5(9)
Ring-necked Dove *Streptopelia capicola*	16(25)	22(46)
Emerald-spotted Wood Dove *Turtur chalcospilos*	17(24)	18(33)
[F]Tambourine Dove *Turtur tympanistria*	0(0)	1(1)
[F]African Green Pigeon *Treron calvus*	1(1)	7(52)
Hamerkop *Scopus umbretta*	1(2)	0(0)
Palmnut Vulture *Gypohierax angolensis*	1(1)	0(0)
Brown Snake-Eagle *Circaetus cinereus*	0(0)	1(1)
[F]Bat Hawk *Macheiramphus alcinus*	0(0)	1(1)
Ayres's Hawk Eagle *Hieraaetus ayresii*	1(1)	0(0)
African Hawk Eagle *Aquila spilogaster*	0(0)	1(1)
Lizard Buzzard *Kaupifalco monogrammicus*	4(4)	3(3)
Dark-chanting Goshawk *Melierax metabates*	0(0)	1(1)
Common Buzzard *Buteo buteo* PM	1(1)	0(0)
Pearl-spotted Owlet *Glaucidium perlatum*	1(1)	0(0)
African Barred Owlet *Glaucidium capense*	0(0)	1(1)
Speckled Mousebird *Colius striatus*	1(2)	4(18)
African Hoopoe *Upupa africana*	0(0)	5(17)
Green Wood Hoopoe *Phoeniculus purpureus*	0(0)	2(4)
Common Scimitarbill *Rhinopomastus cyanomelas*	7(13)	12(19)
Southern Ground Hornbill *Bucorvus leadbeateri*	1(1)	1(4)
Crowned Hornbill *Lophoceros alboterminatus*	0(0)	6(11)
Pale-billed Hornbill *Lophoceros pallidirostris*	1(6)	0(0)
[F]Trumpeter Hornbill *Bycanistes bucinator*	1(2)	1(2)
Racket-tailed Roller *Coracias spatulatus*	2(4)	6(12)
Broad-billed Roller *Eurystomus glaucurus* IM	0(0)	5(18)
Grey-headed Kingfisher *Halcyon leucocephala* IM	1(1)	2(2)
Brown-hooded Kingfisher *Halcyon albiventris*	0(0)	1(1)
Striped Kingfisher *Halcyon chelicuti*	1(1)	11(13)
Woodland Kingfisher *Halcyon senegalensis* IM	0(0)	3(7)
African Pygmy Kingfisher *Ispidina picta* IM	0(0)	1(1)
Little Bee-eater *Merops pusillus*	1(3)	3(7)
Böhm's Bee-eater *Merops boehmi*	1(4)	3(6)

Species	Relative frequency	
	Mbarang'andu (n = 62)	Kimbanda (n = 60)
Olive Bee-eater *Merops superciliosus* IM	0(0)	1(8)
[F]Yellow-rumped Tinkerbird *Pogoniulus bilineatus*	2(2)	11(14)
Yellow-fronted Tinkerbird *Pogoniulus chrysoconus*	6(6)	6(6)
Black-collared Barbet *Lybius torquatus*	0(0)	3(5)
Brown-breasted Barbet *Lybius melanopterus*	1(1)	0(0)
Lesser Honeyguide *Indicator minor*	1(1)	1(1)
Scaly-throated Honeyguide *Indicator variegatus*	2(3)	0(0)
Greater Honeyguide *Indicator indicator*	5(5)	2(2)
Speckle-throated Woodpecker *Campethera scriptoricauda*	4(4)	2(3)
[F]Golden-tailed Woodpecker *Campethera abingoni*	0(0)	9(21)
Bearded Woodpecker *Chloropicus namaquus*	5(8)	1(1)
Cardinal Woodpecker *Dendropicos fuscescens*	2(2)	1(1)
Stierling's Woodpecker *Dendropicos stierlingi*	11(18)	7(9)
Dickinson's Kestrel *Falco dickinsoni*	0(0)	3(5)
[F]Brown-headed Parrot *Poicephalus cryptoxanthus*	6(20)	6(26)
[F]African Broadbill *Smithornis capensis*	0(0)	3(4)
Chinspot Batis *Batis molitor*	10(36)	3(7)
[F]Pale Batis *Batis soror*	24(80)	27(60)
[F]Black-throated Wattle-eye *Platysteira peltata*	0(0)	1(1)
Grey-headed Bush-shrike *Malaconotus blanchoti*	3(3)	6(6)
Orange-breasted Bush-shrike *Chlorophoneus sulfureopectus*	1(1)	5(6)
Brown-crowned Tchagra *Tchagra australis*	1(1)	3(3)
Black-crowned Tchagra *Tchagra senegalus*	16(21)	28(40)
[F]Black-backed Puffback *Dryoscopus cubla*	19(39)	24(55)
Tropical Boubou *Laniarius major*	4(5)	12(20)
Brubru *Nilaus afer*	13(22)	9(10)
White-crested Helmet Shrike *Prionops plumatus*	4(52)	6(100)
Retz' Helmetshrike *Prionops retzii*	3(34)	3(26)
White-breasted Cuckoo-Shrike *Ceblepyris pectoralis*	8(17)	11(20)
Black Cuckoo-shrike *Campephaga flava* IM	2(2)	1(3)
Red-backed Shrike *Lanius collurio* PM	2(2)	0(0)
Southern Fiscal *Lanius collaris*	0(0)	1(1)
Black-headed Oriole *Oriolus larvatus*	15(18)	24(46)
African Golden Oriole *Oriolus auratus* IM	0(0)	3(3)
[F]Square-tailed Drongo *Dicrurus ludwigii*	5(11)	6(18)
Fork-tailed Drongo *Dicrurus adsimilis*	10(22)	25(66)
African Paradise Flycatcher *Terpsiphone viridis* IM	6(13)	21(52)
[F]White-tailed Blue Flycatcher *Elminia albicauda*	4(7)	0(0)
White-bellied Tit *Melaniparus albiventris*	0(0)	2(2)
Cinnamon-breasted Tit *Melaniparus pallidiventris*	13(44)	5(16)
Grey Penduline-Tit *Anthoscopus caroli*	1(2)	1(3)
[F]Eastern Nicator *Nicator gularis*	0(0)	3(4)
Flappet Lark *Mirafra rufocinnamomea*	0(0)	7(8)
Dark-capped Bulbul *Pycnonotus tricolor*	18(48)	20(50)
[F]Little Greenbul *Eurillas virens*	1(1)	0(0)
[F]Yellow-bellied Greenbul *Chlorocichla flaviventris*	2(2)	6(17)
Black Saw-wing *Psalidoprocne pristoptera*	1(6)	1(2)

Species	Relative frequency Mbarang'andu (n=62)	Relative frequency Kimbanda (n=60)
Wire-tailed Swallow *Hirundo smithii*	0(0)	1(2)
Lesser Striped Swallow *Cecropis abyssinica*	2(20)	0(0)
Moustached Grass Warbler *Melocichla mentalis*	0(0)	2(4)
Red-faced Crombec *Sylvietta whytii*	15(28)	6(12)
Red-faced Cisticola *Cisticola erythrops*	0(0)	7(29)
Rattling cisticola *Cisticola chiniana*	0(0)	13(37)
Croaking Cisticola *Cisticola natalensis*	1(1)	3(10)
Neddicky *Cisticola fulvicapilla*	23(56)	17(43)
Tawny-flanked Prinia *Prinia subflava*	1(3)	9(24)
Yellow-breasted Apalis *Apalis flavida*	1(3)	2(2)
Green-backed Camaroptera *Camaroptera brachyura*	2(7)	8(21)
Stierling's Wren-Warbler *Calamonastes stierlingi*	8(16)	8(14)
Yellow-bellied Eremomela *Eremomela icteropygialis*	1(2)	4(8)
^{F}Green-capped Eremomela *Eremomela scotops*	6(19)	7(13)
Arrow-marked Babbler *Turdoides jardineii*	1(5)	1(1)
Southern Yellow White-eye *Zosterops anderssoni*	1(6)	7(59)
^{F}Yellow-bellied Hyliota *Hyliota flavigaster*	5(19)	6(29)
African Spotted Creeper *Salpornis salvadori*	5(9)	3(5)
Miombo Blue-eared Starling *Lamprotornis elisabeth*	0(0)	1(6)
Violet-backed Starling *Cinnyricinclus leucogaster* IM	0(0)	15(121)
Kurrichane Thrush *Turdus libonyana*	5(7)	6(8)
Bearded Scrub-Robin *Cercotrichas quadrivirgata*	1(3)	0(0)
White-browed Scrub-Robin *Cercotrichas leucophrys*	5(6)	7(9)
Grey Tit-Flycatcher *Myioparus plumbeus*	1(1)	0(0)
Southern Black Flycatcher *Melaenornis pammelaina*	4(7)	7(12)
Pale Flycatcher *Melaenornis pallidus*	2(2)	8(20)
Spotted Flycatcher *Melaenornis striata* PM	1(2)	5(8)
^{F}Ashy Flycatcher *Muscicapa caerulescens*	3(7)	2(2)
^{F}African Dusky Flycatcher *Muscicapa adusta*	2(4)	1(1)
Böhm's Flycatcher *Muscicapa boehmi*	0(0)	1(1)
White-browed Robin-Chat *Cossypha heuglini*	1(1)	5(6)
^{F}Red-capped Robin-Chat *Cossypha natalensis* IM	1(1)	0(0)
Semicollared Flycatcher *Ficedula semitorquata* PM	2(2)	2(3)
Miombo Rock Thrush *Monticola angolensis*	2(3)	0(0)
Arnott's Chat *Myrmecocichla arnotti*	5(11)	12(30)
Familiar Chat *Oenanthe familiaris*	0(0)	1(2)
Western Violet-backed Sunbird *Anthreptes longuemarei*	21(42)	20(43)
Collared Sunbird *Hedydipna collaris*	4(9)	1(2)
Amethyst Sunbird *Chalcomitra amethystina*	11(28)	10(19)
Scarlet-chested Sunbird *Chalcomitra senegalensis*	1(2)	7(15)
Eastern Miombo Sunbird *Cinnyris manoensis*	22(66)	0(0)
Shelley's Sunbird *Cinnyris shelleyi*	6(19)	3(4)
Yellow-throated Bush-Sparrow *Gymnoris superciliaris*	25(85)	21(80)
White-browed Sparrow-Weaver *Plocepasser mahali*	0(0)	2(4)
Holub's Golden Weaver *Ploceus xanthops*	2(7)	2(2)
Village Weaver *Ploceus cucullatus*	0(0)	2(19)
Olive-headed Weaver *Ploceus olivaceiceps*	4(7)	0(0)

Species	Relative frequency	
	Mbarang'andu (n = 62)	Kimbanda (n = 60)
Red-headed Weaver *Anaplectes rubriceps*	1(1)	2(5)
Black-winged Red Bishop *Euplectes hordeaceus*	2(4)	1(2)
Yellow-Bishop *Euplectes capensis*	2(10)	12(35)
Green-winged Pytilia *Pytilia melba*	0(0)	1(2)
Red-billed Firefinch *Lagonosticta senegala*	0(0)	2(5)
African Firefinch *Lagonosticta rubricata*	1(1)	5(16)
Blue Cordonbleu *Uraeginthus angolensis*	1(5)	5(17)
Common Waxbill *Estrilda astrild*	0(0)	1(12)
Orange-breasted Waxbill *Amandava subflava*	0(0)	3(180)
Bronze Mannikin *Spermestes cucullata*	2(6)	1(12)
Black-and-White Mannikin *Spermestes bicolor*	2(14)	1(6)
Village Indigobird *Vidua chalybeata*	0(0)	1(2)
Pin-tailed Whydah *Vidua macroura*	1(7)	2(10)
Long-tailed Paradise Whydah *Vidua paradisaea*	0(0)	1(1)
Broad-tailed Paradise Whydah *Vidua obtusa*	1(1)	1(1)
Yellow-throated Longclaw *Macronyx croceus*	0(0)	1(2)
Yellow-fronted Canary *Crithagra mozambica*	12(22)	10(50)
Black-eared Seed-eater *Crithagra mennelli*	2(3)	5(25)
Golden-breasted Bunting *Emberiza flaviventris*	1(1)	3(5)
Cabanis's Bunting *Emberiza cabanisi*	3(4)	4(9)

Short communications

Miombo Blue-eared Starlings *Lamprotornis elisabeth* in Dakatcha Woodland, coastal Kenya

Dakatcha Woodland (3°01′S, 39°51′E), northwest of Malindi, Kenya, is a mosaic of extensive *Brachystegia spiciformis* forest, interspersed with farmland, thicket, abandoned farmland, *Cynometra* forest, mixed forest, mixed woodland, some tree plantations, patches of grassland, and small seasonal wetlands. It is also a Key Biodiversity Area (an Important Bird Area) because it shelters populations of several threatened birds. Naturally, birders tend to focus on Clarke's Weaver *Ploceus golandi*, Sokoke Scops Owl *Otus ireneae* and Sokoke Pipit *Anthus sokokensis*, each considered endangered, or the beautiful Fischer's Turaco *Tauraco fischeri* and the Southern Banded Snake Eagle *Circaetus fasciolatus*, which are considered near-threatened (IUCN 2021).

Greater Blue-eared Starlings *Lamprotornis chalybaeus* tend to be viewed as a common generalist species in Kenya, seen in farmland and bush as well as at forest edge. According to Zimmerman *et al.* (1996), Greater Blue-eared Starlings of the subspecies *sycobius* range throughout the coastal lowlands south of Malindi (3°22′S, 40°11′E), while there are also very old coastal records of the much rarer Miombo Blue-eared Starling *Lamprotornis elisabeth* from south coastal Kenya at Vanga, from Mombasa and from Mongeya Hill at the western edge of Sokoke Forest, again all south of Malindi. Neither of these blue-eared starling species are expected, therefore, north of the Malindi area in central coastal Kenya. In addition, it should be noted that Miombo Blue-eared Starling was formerly considered a sub-species of Lesser Blue-eared Starling *L. chloropterus* (e.g., see Zimmerman *et al.* 1996, Fry *et al.* 2000). While mostly treated as a distinct species today (e.g., see Stevenson & Fanshawe 2020, Gill *et al.* 2021) some authorities still include it with Lesser Blue-eared Starling (Clements *et al.* 2021).

When Nature Kenya and Dakatcha Woodland Conservation Group began to monitor birds at Dakatcha fifteen years ago, blue-eared starlings were occasionally observed, and they were included as Greater Blue-eared Starling, being 'regular' in frequency, in the *Checklist of the Birds of Dakatcha Woodland* (Nature Kenya 2009). They were thought to be Greater Blue-eared Starlings on the basis of expected presence of this species only 40 km to the south of Dakatcha. Whenever we had good views of these birds, we tried to see the features of the coastal subspecies *sycobius* (vs. the inland subspecies *cyaniventris*) but did not spend much time on this or reach any definitive conclusion. In the past five or six years, blue-eared starlings have been seen more regularly, possibly because more forest has been cleared for farmland.

On 22–29 March 2018, Dakatcha Woodland Conservation Group and Nature Kenya carried out several days of Common Bird Monitoring, part of the IBA Monitoring protocol. *Brachystegia* trees were in bright new leaf, and on our way back from monitoring a seasonal wetland, we saw a large tree full of starlings, some distance away above a thicket. These birds looked much like Greater Blue-eared Starlings, but we could see patches of reddish colour among them. With binoculars, we saw that some birds were immatures, and showed rufous-brown underparts. We were confused because we knew that Greater Blue-eared Starling immatures have dark 'sooty' brown underparts, having seen them elsewhere in Kenya. This was the second time we had

seen such a flock in Dakatcha, and despite seeing the birds quite well on this occasion, we were unable to obtain photographs to help with the identification of these unusual starlings.

Three years later on 18 June 2021, while monitoring birds with the Dakatcha Woodland Conservation Group, we finally obtained photographs of the starlings at Nature Kenya's Kamale Nature Reserve in Dakatcha (2°43.3′ S, 39°56.8′ E). The photographs, taken by JM (Fig. 1), were shared with local birders and the identification was suggested to be Miombo Blue-eared Starling on the basis of the rusty underpart tones of the immature birds, with patches of glossy-blue growing in (Stevenson & Fanshawe 2020).

Figure 1. Immature Miombo Blue-eared Starlings *Lamprotornis elisabeth* at Dakatcha Woodland on 18 June 2021, showing the characteristic rusty underparts with glossy-blue adult feathers growing in (photo: J. Mwambire).

This record of Miombo Blue-eared Starling was subsequently submitted to the East Africa Rarities Committee and accepted in September 2021 as the first confirmed record in Kenya for many decades (N. Hunter, pers. comm.). Monitoring of blue-eared starlings in Dakatcha will now be undertaken with specific attention to vocalizations, in an effort to determine the status of the Miombo Blue-eared Starling and Greater Blue-eared Starling north of the Sabaki-Galana River.

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A record of partial leucism in the Moorland Chat *Cercomela sordida* at Bale Mountains National Park, southeastern Ethiopia

The Moorland Chat *Cercomela sordida* is a common Afrotopical resident in alpine moorlands of Ethiopia and Eritrea from 1820 to 3340 m, extending to adjacent cultivated areas and stony scrublands (Ash & Atkins 2009, Redman *et al.* 2009). In the Bale Mountains, however, we have also recorded it numerous times up to 4377 m at Tullu Dimtu, the highest peak. The species is a small, short-tailed, dark brown chat with wheatear-like tail pattern: white bases to the outer rectrices and dark central rectrices and tail tip, forming an inverted 'T'. It is paler grey-brown below; bill black; eyes dark brown; legs and feet black (Redman *et al.* 2009). There has also been an observation of a partially leucistic Moorland Chat, all grey with white remiges and tertials and a partly white head, near Debre Birhan, Ethiopia (Ash & Atkins 2009). Here, we present another record of partial leucism in the Moorland Chat.

In the early morning of 28 March 2022, AS observed three unusual birds in a mixed flock near Fincha'a Habera (7°01′24″ N, 39°43′15″ E; 3520 m asl.) in the Bale Mountains National Park, Ethiopia which were identified as partially leucistic Moorland Chats (Fig. 1). There were two other normal Moorland Chats present in the group and a Thekla's Lark *Galerida theklae*. The habitat where they were observed was a rocky grassland and moorland where *Kniphofia foliosa* and *Artemisia afra* are dominant.

The three birds with abnormal plumage were the same size as the normal adult chats, although sex could not be determined as both sexes are alike and larger than the immature bird, which we were well familiar with from our work in the park. The birds appeared as typical Moorland Chats except for having white-coloured feathers on the face (ear coverts, supercilium, chin and throat), a white ring around neck that extended to the nape, and white spots on wing feathers. The bill and tarsi are normally black, but were light yellow in these birds (Fig. 1), consistent with previous reports indicating that partially leucistic birds may, or may not, have normally coloured bill and legs (van Grouw 2013).

Notable behaviours observed included frequent flicking of the tail and wings, and dropping from shrubs onto insects on ground; both of these are typical behaviour of Moorland Chats. Although the three aberrant birds were mobile with respect to the other birds present, no antagonistic interactions were observed between the partially leucistic birds or with the normally patterned individuals.

Plumage abnormality in birds is rare in nature, but is still insufficiently studied globally (Guay *et al.* 2012). In places such as the Afrotropical region, where only sporadic documentations are available and observations of such cases are often not published, reporting such observations helps in ascertaining the prevalence of the condition and to study its causes and consequences. Our present report represents only the second record of partial leucism in the Moorland Chat.

Figure 1. Partial leucistic Moorland Chat *Cercomela sordida* photographed at the Bale Mountains National Park, southeast Ethiopia, on 28 March 2022, showing sides of the head (left and center) and nape (right) (photos: A. Sultan).

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Field notes on two subspecies of the Variable Sunbird *Cinnyris venustus* in an area of parapatry in western Kenya

The subspecies *falkensteini* is the common Variable Sunbird *Cinnyris venustus* taxon in much of Kenya, being present in gardens and shrub habitats in the central Kenya highlands, extending west to Mt Elgon, Bungoma, Kakamega, Kisumu and the Lambwe Valley (Britton 1980, Zimmerman *et al.* 1996, JB, pers. obs.). Meanwhile, the subspecies *igneiventris* is strictly western, occurring from lowlands in Uganda eastwards into western lowland areas of Kenya at Malaba, Bungoma and Siaya (Britton 1980, Zimmerman *et al.* 1996, JB, pers. obs.).

On 19 November 2021 we birded a small rocky hill 6 km north of Bungoma at 0°37.3′ N, 34°33.17′ E in western Kenya, at the periphery of the range of *falkensteini*, and simultaneously made close observations of both this form and taxon *igneiventris*. These two taxa were apparently coexisting side by side, but were evidently separated ecologically and behaviourally in a number ways.

Here we detail our field observations of these two sunbird taxa across a distance of barely 200 m, commenting on differences in appearance, song, behaviour and habitat selection.

Habitat selection and physical appearance

We found a single individual of taxon *igneiventris* near the top of the rocky hill that we were surveying at an altitude of 1550 m. The area consisted of huge granite boulders with interspersed pockets of trees including species from the genera *Combretum*, *Erythrina* and *Terminalia*. When we saw the bird making the fast and unfamiliar trilling song, we immediately recognized it as this form on the basis of a strong orange wash to the upper breast, becoming whitish on the lower belly and undertail coverts (Fig. 1A). We noted the upperparts to be particularly blue, with barely a hint of green. Unfortunately, we did not see a female or a juvenile male that was present as well, although the poor photograph we obtained of the male showed a bird that resembled exactly an individual we had seen nearby at Mumias (0°23′11″ N, 34°30′46″ E) the previous day (Fig. 1B).

Following our observations of *igneiventris* at the hill top, we descended to the base of the hill at an elevation of 1525 m, and only 230 m distance from the top of the hill, where we heard and immediately recognized the slower and less twittering Variable Sunbird song with which we were familiar from Nairobi. On sighting one of three singing males, it clearly lacked the orange wash to the breast, being a uniform sunshine yellow almost to the undertail coverts, which were a slightly dirtier whitish colour than in the *igneiventris* male seen 15 minutes previously. We confidently referred these males to the form *falkensteini* (Fig. 1C), and also noted the upperparts to be distinctly greener than in the *igneiventris* male, and again, consistent with the appearance of birds eastwards in the central Kenya highlands. The three *falkensteini* males were observed in taller woodland with a more complete canopy than at the hill top, and which was comprised solely of mature *Acacia polyacantha*. To us, this area at the base of the hill felt slightly cooler and more humid than the summit of the hill, perhaps as a result of being more shaded by the large trees, and in being less exposed to the drying effect of the sun.

Figure 1. Images of the Variable Sunbird subspecies *C. v. igneiventris* at Bungoma (A; J. Bradley) and at Mumias (B; P. Steward), and of *C. v. falkensteini* (C; J. Bradley) at Bungoma on 18-19 November 2021, with upperparts bluer, breast more orange vs. yellow, and lower underparts whiter in the *C. v. igneiventris* males.

Vocalizations and behaviour

Before observing taxon *igneiventris* at the hill top, we were drawn to it by its song. This was unlike the song of birds in Nairobi, referable to *falkensteini*, and was not recognized as the voice of Variable Sunbird by either of us, and we are very familiar with the song of *falkensteini* from central Kenya. It was with some surprise that we found the bird to be a Variable Sunbird when we did finally set eyes on it. We observed it several times, but only briefly as the bird was highly mobile and actively chasing a single female (or juvenile male) around the trees on the hilltop. The song was noted to be fast and the typical phrases of the same repeated notes were interspersed with more varied and creative phrases incorporating notes with a sizzling and/or rapid chittering quality. From recordings taken on site (Fig. 2a, recording archived at ML#392791291), it could be seen that the delivery rate of notes in the typical phase was 14.4 notes/second, and that the phrase begins with three to four short and clean, squeaky introductory notes. Gaps between phrases were measured to range from 2.1 to 7.9 seconds.

As with *igneiventris*, we were alerted to the individuals of *falkensteini* at the base of the hill by their song, which was consistent with what we were familiar with for the species. Three males were singing in a small area measuring approximately 50 m across, and were highly static, remaining in their chosen trees and favoured perches, unlike the feverish activity of the *igneiventris* male on the hill top. No females were observed and the males seemed engaged purely in counter singing. The song was audibly slower than that of the *igneiventris* male with the repeated notes of the typical phrase being delivered at 8.8 notes/second (Fig. 2b, recording archived at ML#392791321). Additionally, the phrase was not varied but remained the same for each repetition, and was introduced not by clean squeaky notes as in the *igneiventris* male but by either two short whistles or two distinctive sounding buzzy notes. All three of the *falkensteini* males were singing the same song phrase and the gap between phrases averaged longer than in the song of the *igneiventris* male, ranging from 4.5 to 10.7 seconds.

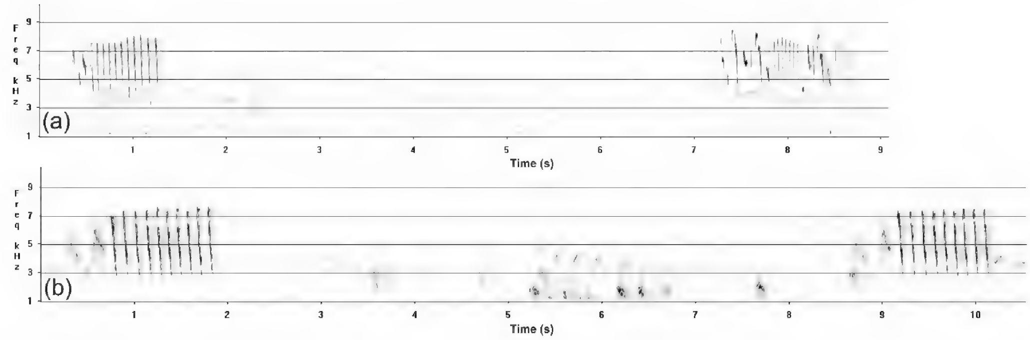

Figure 2. Sonograms of the song phrases of the Variable Sunbird subspecies *C. v. igneiventris* (a) and *C. v. falkensteini* (b) recorded in close proximity to each other near Bungoma on 18–19 November 2021, showing the faster delivery and more varied phrases of *igneiventris* (audio: J. Bradley).

Discussion

That two visually and vocally distinctive forms of the Variable Sunbird occur together in parts of western Kenya is not widely recognized. Granvik (1934), however, noted that some birds in the Mt Elgon region have the belly colour orange-yellow, and others plain chrome-yellow, presumably reflecting the two different taxa discussed here.

Whether the differences in vocalizations we recorded are maintained by each form, respectively, with increasing distance away from zones of overlap, is not known. We considered the possibility that the *igneiventris* male was singing a fast, high and twittering song different to the song of the *falkensteini* males on account of the female (or juvenile male) observed to be present with that bird. However, this seems unlikely to us as we are quite familiar with the song of *falkensteini* in the central highlands at Nairobi, and have never heard this song there at any time of year. While beyond the scope of this study, a review of vocalizations across a wider area could be informative in ascertaining whether the differences in song between the two taxa that we noted are consistent everywhere. We note further that not only were appearance and song of the birds different but the two taxa appeared to show quite different habitat preferences and behaviour on the date they were observed as well.

Based on the differences we observed, it seems possible that these two forms are reproductively isolated in this narrow area of parapatry where they appear to be separated by a mere 230 m. Further research should specifically seek establish whether this is the case, as well as to more accurately define the extent of any broader overlap in range for these two taxa. A molecular comparison of the two forms to assess the level of correlation between any genetic divergence and the phenotypic, behavioural and vocal differences we observed, could also be informative.

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Comments on the taxonomy and evolutionary relationships of some East African 'Red-winged' francolins currently recognized as *Scleroptila g. gutturalis/lorti/archeri*, *Scleroptila s. shelleyi* and *S. s. uluensis*

The taxonomy and phylogenetic (evolutionary genealogical) relationships of East African members of Hall's (1963) taxonomically un-designated 'Red-winged Group' of *Francolinus* spp. *sensu lato* have complex taxonomic and phylogenetic histories. All three of the forms investigated here were described originally as members of the phasianid genus *Francolinus* (Stephens, 1819), but Crowe *et al.* (1992) provide morpho-molecular evidence supporting splitting them and the Ring-necked Francolin (*streptophora*—Ogilvie-Grant, 1891) off into *Scleroptila* (Blyth, 1852). Hall (1963: p. 153) describes her 'red-wings' as sexually monomorphic, medium-sized perdicines that have "quail-type" patterned upperparts with a lattice-work pattern of irregular white and buff bars and shaft streaks on a basic colour of mixed black, brown, grey and chestnut. They have variable amounts of rufous in the wings, marked facial patterning, black bills (usually with a yellowish base) and yellowish legs, spurred in the males.

Distribution, habitat and morphology

Based on species accounts in Hall (1963), Mandiwana-Neudani *et al.* (2019) and Little (2021), the northern forms of *Scleroptila gutturalis* inhabit insular blocks and smaller fragments that straddle the highlands of Eritrea, northern Somalia, Ethiopia and South Sudan, south to northeastern Uganda at Kidepo National Park and Mt Moroto, and the Huri Hills in northern Kenya. It inhabits blocks and fragments of sparse grassland in arid acacia steppe on rocky hillsides and mountains from 600 to 2100 m. It differs from other 'red-winged' francolins in having a buff throat-patch with ill-defined dark freckles (*gutturalis*) above a well-defined necklace with the abdomen marked with black streaks on the feather centres and flanks broadly streaked with chestnut. Throughout its range, there is marked variation in overall plumage colour characterized by grey and rufous populations. The greyest forms (*lorti*) occur in northern Somalia and eastern Ethiopia and a mosaic of rufous and greyish micro-populations (*archeri*, including *friedmanni* and *stantoni*) in southern Ethiopia, South Sudan, northeastern Uganda and northern Kenya.

Shelley's Francolin *Scleroptila s. shelleyi* has a patchy range from south-eastern Rwanda, western and southern Tanzania south to southeastern, eastern Democratic Republic of Congo, Zambia, northern Malawi, Zimbabwe, Mozambique, Eswatini (formerly Swaziland) and South Africa. It inhabits moist, rocky hillsides in miombo and mopane woodlands below 2000 m. It has a buff to white throat-patch above a distinct black necklace, a breast blotched and mottled with maroon, chestnut and grey and a white abdomen irregularly broadly spotted and barred black.

Scleroptila s. uluensis ranges from central and southern Kenya south to northern Tanzania in the Mbulu and Crater Highlands, Arusha and Tarangire National Parks. It inhabits acacia grasslands from 1500 to 2000 m. It is similar to nominate *shelleyi*, but the necklace and throat-patch are somewhat less distinct and the bill markedly shorter. Some specimens have the throat moderately freckled with black like *Scleroptila gutturalis*.

Pre-1963 taxonomy

Peters (1934) recognized five species and 21 subspecies of 'Red-winged' Francolins:

1. ***africanus*** (Stephens, 1819): *africanus, gutturalis* (Rüppell, 1835), *eritreae* (Zedlitz, 1910), *lorti* (Sharpe, 1897), *psilolaemus* (Gray, 1867), *ellenbecki* (Erlanger, 1905), *archeri* (Sclater, 1927) and *uluensis* (Ogilvie-Grant, 1892).
2. ***shelleyi*** (Ogilvie-Grant, 1890): *shelleyi, elgonensis* (Ogilvie-Grant, 1891), *trothae* (Reichenow, 1901), *whytei* (Neumann, 1908).
3. ***levaillantii*** (Valenciennes, 1825): *levaillantii, kikuyuensis* (Ogilvie-Grant, 1897), *crawshayi* (Ogilvie-Grant, 1896), *benguellensis* (Neumann, 1908).
4. ***finschi*** (Bocage, 1881).
5. ***gariepensis*** (A. Smith, 1843) superseded by ***levalliantoides*** (A. Smith, 1836): *levalliantoides, jugularis* (Büttikofer, 1889), *pallidior* (Neumann, 1908), *langi* Roberts, 1932, *ludwigi* (Neumann, 1920).

Mackworth-Praed & Grant (1952, 1962) recognized five species and 26 subspecies:

1. ***afer***=*afra* (Latham, 1790): *afer, uluensis, psilolemus, ellenbecki, gutturalis, lorti, archeri, friedmanni* (Grant & Mackworth-Praed 1934), *macarthuri* (Van Someren 1938) and *stantoni* (Cave 1940).
2. ***shelleyi***: *shelleyi, whytei, elgonensis* and *theresae* (Meinertzhagen 1937).
3. ***levalliantoides***: *levalliantoides, kalaharica* (Roberts 1932), *pallidior, langi* (Roberts, 1932), *wattii* (Macdonald 1953), *jugularis* (Buttikofer, 1889) and *cunenensis* (Roberts, 1932).
4. ***levaillantii***: *levaillantii, kikuyuensis, crawshayi, benguellensis* and *clayi* (White, 1944).
5. ***finschi*** (Bocage, 1881).

Mackworth-Praed & Grant correctly regarded '*afra*' as the senior name of the South African Grey-wing Francolin, generally known as *Francolinus africanus* (Stephens, 1819). However, when *Pternistis* spurfowls were submerged within *Francolinus*, *Perdix afra* Latham, 1790 is pre-occupied by *Tetrao afer* (S. Muller, 1776), the senior name for the bare-throated spurfowl known as *P. afer*. Thus, the South African Grey-winged Francolin must therefore bear the specific epithet *afra*.

In her highly influential monograph, Hall (1963: 153) disagreed with previous classifications of 'red-winged' francolins, which she felt placed "too great a reliance on minor morphological characters, particularly the size of the bill, without regard to the ecology of the forms of (*sic*) their likely evolution". Her markedly different taxonomy recognized six species and 18 subspecies:

1. **The Montane Redwing** *Francolinus psilolaemus* (Gray 1867) including all other montane forms from Kenya, Uganda and Ethiopia: *psilolaemus, ellenbecki, elgonensis* and *theresae*. All of these taxa are found in heath and grasslands above 2450 m, have a high proportion of rich chestnut in the wings and differ from other red-winged francolins in having some barring on the tips of the primaries. The underparts are rich buff mottled with chestnut with some dark brown or black markings.
2. **Shelley's Redwing** *Francolinus shelleyi* (Ogilvie-Grant, 1890) occurs at lower elevations than *psilolaemus* and includes nominate *shelleyi* and *F. s. whytei* (Neumann 1908) and *uluensis* (Ogilvie-Grant 1892) (including *macarthuri* (Van Someren 1938). These taxa differ from *psilolaemus* in having the breast

maroon, chestnut and grey, and have no black below the necklace and gorget that is moderately developed and blotched with reddish-chestnut. The remainder of the underparts are patterned with black and white.

3. **The Greywing** *F. africanus* (= *F. afer*) differs from other 'redwings' in having a white throat bordered with black freckling and much reduced rufous in the wings. The black barring on the buffy abdomen is narrow, whereas the barring on the underparts of some other 'red-wing' taxa is broad.
4. **Acacia Redwing** *F. levaillantoides* (A. Smith, 1836) comprising what Mackworth-Praed & Grant (1952) recognized as the northern forms of the Grey-wing (*gutturalis, archeri, lorti, stantoni* and *friedmanni*), and four southern African taxa (*levaillantoides*, *kalaharica, pallidior* and *jugularis*), all of which have only very limited amounts of chestnut in the wings.
5. **Levaillant's Redwing** *F.l. levaillantii, F.l. crawshayi* and *F.l. kikuyuensis*, which differ from other 'red-wings' in having an ochre collar and the sides of face and edges of the throat ochre inside the black-and-white facial pattern.
6. **Finsch's Redwing** *F. finschi* differs from other 'red-wings' in lacking the black-and-white patterning on the face and neck and having a grey breast.

Post-1963 taxonomy

White (1965) largely followed Hall, placing *uluensis* (including *macarthuri*) within *F. shelleyi*, and *gutturalis, archeri* and *lorti* within *F. levalliantoides*. Later, Snow (1978) commented that within Shelley's Francolin *Francolinus shelleyi* there was marked geographical variation, with two forms worthy of recognition: the small-billed northern 'acacia' bird (*F. africanus uluensis*) and the long-billed southern 'miombo and mopane' bird (*F.s. shelleyi*).

For East Africa, both Britton (1980) and Zimmerman *et al.* (1996) recognized Smith's Francolin (*Francolinus levaillantoides archeri*), Moorland Francolin (*F. psilolaemus elgonensis* and *F.p. theresae*) and Shelley's Francolin (*F.s. shelleyi, F.s. uluensis* and *F.s. macarthuri*).

Meanwhile, the current IOC World Bird List Version 12.1 (Gill *et al.* 2022) recognizes *Scleroptila gutturalis* as a widely distributed, polytypic species with two highly disjunctly distributed clusters of three subspecies in northeastern Africa [*gutturalis* (Rüppell, 1835), *lorti* (Sharpe, 1897), *archeri* (Sclater, 1927)] and southern Africa [*levalliantoides* (A. Smith, 1836), *jugularis* (Büttikofer, 1889) and *pallidior* (Neumann, 1908)]. It treats *uluensis* (Ogilvie-Grant, 1892) as a northern subspecies of *Scleroptila shelleyi* (Ogilvie-Grant, 1890).

Over the years, all forms of Hall's 'Acacia Redwing' have often been erroneously referred to as *Francolinus levaillantoides*, but the mis-spelled species epithet was corrected to *levalliantoides* as originally spelt by Smith (1836). Meanwhile the name *gutturalis* for all northern birds has date priority over *levalliantoides* Smith. As a result, birds from southern Ethiopia, northern Kenya and northeastern Uganda are now referred to as Archer's Francolin *Scleroptila gutturalis archeri* (Turner & Pearson 2015).

Advertisement calls

With regard to variation in advertisement calls within *Scleroptila* spp., Mandiwana *et al.* (2014) separated the calls of the component taxa into two qualitatively distinct subgroups:

1. species with short, four-element *Ki-Keet, ki-KIT* ('I'll drink YER-BEER') strophes (*finschi, levalliantoides, gutturalis* and *shelleyi*).

2. those species with long strophes consisting of many more elements (*streptophora, levaillantii* and *afra*), often ending with a warble.

Interspecific differences in the four-element calls differ primarily in strophe and pause duration. The strophe of *S. levalliantoides* (0.53 s) is the shortest, with those of *S. finschi* (0.71 s), *S. gutturalis* (0.79 s), and *S. shelleyi*, (0.89 s), respectively, increasing in duration. The remaining three species have strophes of much longer duration, (*S. afra*, 2.0 s; *S. levaillantii*, 2.11 s; *S. streptophora*, 2.22 s) and seven to ten elements. The typical advertisement strophes of *S. levalliantoides, S. gutturalis, S. finschi* and *S. shelleyi* are similar in that they have four complex elements with the first two elements introducing the strophes.

Pearson & Coverdale (1991) felt that *archeri* in the Huri Hills of northern Kenya, were vocally very similar to *shelleyi*, and Zimmerman *et al.* (1996) noted that their repetitive "*Ki-Keet, ki-KIT*" four-note call was "faster, more strident and higher-pitched than that of *F. shelleyi uluensis*" which they described as a four-note "ski-UK skiki-eu or ker-kiRRr, ker-kek, repeated several times".

A 'holistic' evolutionary approach

Based on combined morphological, behavioural and DNA sequence divergence studies, Mandiwana-Neudani *et al.* (2019) proposed that, at 3.3% divergence from its phylogenetically closest species (*gutturalis*), *uluensis* may warrant full-species status. *Scleroptila shelleyi*, is closer genetically and clusters phylogenetically with the southern African francolins (Fig. 1) which Mandiwana-Neudani *et al.* (2019) place within a separate species, *Scleroptila levalliantoides* (Orange River Francolin). Moreover, in northeastern Africa, the very low 0.6–1.6% sequence divergence values for *archeri* and *lorti* from *gutturalis* suggest that they are micro-geographic and/or clinal variants that may not warrant taxonomic recognition.

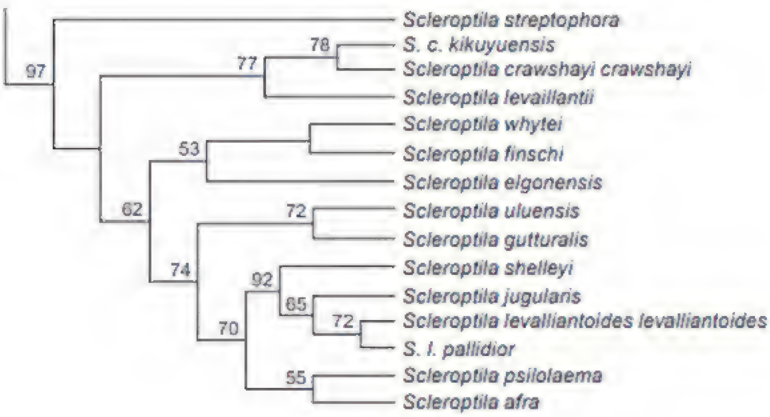

Figure 1. Cladogram (evolutionary tree) for *Scleroptila* francolins. Numbers above branch points are jackknife support values (source: Mandiwana-Neudani *et al.* 2019)

Recommendations

Given the above, it may now be more appropriate to consider *uluensis* as either being a full species as proposed by Mandiwana-Neudani *et al.* (2019), closest to, or as a subspecies of *gutturalis*. There appears to be no strong evidence for continuing to retain *uluensis* as a subspecies of *S. shelleyi*.

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East African Rarities Committee Report for 2021

The East African Rarities Committee assesses records of new and very rare birds occurring in Kenya, Tanzania, Uganda, Rwanda and Burundi. This includes up to the fifth record of any species from each of the five countries. Membership of the committee in 2021 comprised Washington Wachira (Chairman), Neil Baker, Nik Borrow, Brian Finch, Colin Jackson, Johnnie Kamugisha, David Moyer, Nigel Redman, Itai Shanni, Roger Skeen, Terry Stevenson and Don Turner. We are grateful to Dick Forsman, Per Alström, Martin Miske and James Bradley for their help with the assessment of some of these records.

Sightings of species for which there are fewer than five records for a country should be submitted to Nigel Hunter, EARC Secretary, P.O. Box 24803, Karen 00502, Nairobi, Kenya; Email: nigelhunter74@gmail.com. Lists of species with fewer than five records for each country and the EARC rarity form are available as downloads from the EARC website (www.eararities.org). Please contact the Secretary to obtain clarification of whether a record requires a submission and for guidance on what details to include in the submission. Past records of rare species are also sought in order to bring the EARC database up to date.

Category A: Fully accepted Species

African Barred Owlet *Glaucidium capense*

Second to fifth records for Rwanda. Four individual birds were either seen, heard or photographed (Fig. 1) in Akagera National Park on 26 July 2021 (D. Bantlin and L. Abbot).

Golden-tailed Woodpecker *Campethera abingoni*

Third record for Uganda. A single bird was seen and heard on Ishasha Road, Queen Elizabeth National Park on 1 July 2021 (B. Finch and P. Tamwenya).

Black-collared Barbet *Lybius torquatus*

Fifth record for Uganda. Two adult birds and a young bird were seen, heard and photographed in Lake Mburu National Park on 8 July 2021 (B. Finch).

Rufous-crowned Roller *Coracias naevius*

Third record for Rwanda. A single bird was seen and photographed in Akagera National Park on 28 November 2020 (M. Veysal and J-M. Bournazaud).

Dickinson's Kestrel *Falco dickinsoni*

First record for Uganda. A single bird was seen and photographed (Fig. 1) in Murchison Falls National Park on 13 May 2018 (H. Byaruhanga and B. Tuhaise).

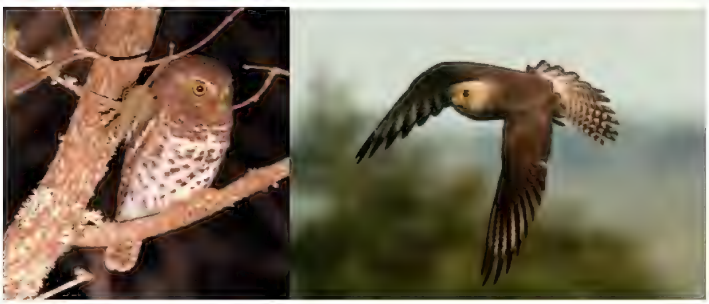

Figure 1. African Barred Owlet *Glaucidium capense* (left: Drew Bantlin) and Dickinson's Kestrel *Falco dickinsoni* (right: Herbert Byaruhanga).

Red-footed Falcon *Falco vespertinus*

Third record for Uganda. Seven birds were seen and photographed (Fig. 2) 30 km before Pakwach (Amuru District) on 26 February 2021 (C. Wanyama).

Amur Falcon *Falco amurensis*

Fourth record for Rwanda. A single bird was seen and photographed at Fazenda (Kigale) at the end of December 2020 (M. Muyenzi).

Willard's Boubou *Laniarius willardi*

Fifth record for Uganda. A single bird was seen, heard and filmed in Bwindi–Impenetrable National Park, Buhoma on 3 July 2021 (B. Finch and P. Tamwenya).

Woodchat Shrike *Lanius senator*

Second record for Rwanda. A single bird was seen and well described at Ntongwe on 3 March 2005 (R. Fleming).

Piapiac *Ptilostomus afer*

First record for Rwanda. A single bird was seen and photographed on Muhana Plains (Akagera National Park) on 2 May 2021 (L. Abbot).

Broad-ringed (Kilimanjaro) White-eye *Zosterops eurycricotus*

First record for Kenya. Six birds were seen, heard and photographed (Fig. 2) in Oloitokitok Forest (Loitokitok District, Kajiado County) between 12 and 29 May 2021 (I. Kilisu, T. Davis. J. Lairumbe and E. Lairumbe). The taxonomy of white-eyes has recently undergone a significant revision. The taxonomy used here follows that outlined in Pearson & Turner (2017), based on the phylogeny of Cox *et al.* (2014). More detailed information with regard to this species and its occurrence at Oloitokitok can be found in Bradley *et al.* (2022).

Rose-coloured Starling *Pastor roseus*

Second record for Kenya. A single bird in immature plumage was seen and photographed (Fig. 3) in Nairobi National Park on 9 October 2021 (A. Scott Kennedy, B. Finch and N. Hunter).

Figure 2. Red-footed Falcon *Falco vespertinus* (left: Crammy Wanyama) and Broad-ringed White-eye *Zosterops eurycricotus* (right: Tyler Davis).

Miombo Blue-eared Starling *Lamprotornis elisabeth*

Fifth record for Kenya. Several birds, including immatures, were seen and photographed in mixed woodland in Kilifi County on 18 June 2021 (J. Mwambire and F. Ng'weno). There are at least four traceable specimens of this species from Kenya—all collected between 1910 and 1959. This is therefore the first documented record for 62 years. This taxon was formerly treated as a subspecies of Lesser Blue-eared Starling *L. chloropterus*.

Capped Wheatear *Oenanthe pileata*

Third record for Uganda. A single bird was seen and photographed (Fig. 3) in Queen Elizabeth National Park on 3 January 2021 (B. Arshley).

Desert Wheatear *Oenanthe deserti*

Fifth record for Kenya. A single bird was seen and very well described (including the characteristic all-black distal half of the tail) at Kensalt Saltworks, Gongoni (Kilifi County) on 26 January 2021 (C. Jackson, A. Omenya and D. Kazungu).

Figure 3. Rose-coloured Starling *Pastor roseus* (left: Adam Scott Kennedy) and Capped Wheatear *Oenanthe pileata* (right: Brian Arshley).

Category D: Identification accepted but provenance uncertain

The following record could not be confirmed as new for Uganda as it was not possible to establish that the bird was not an escape from captivity:

Livingstone's Turaco *Tauraco livingstonii*

A single bird was seen and photographed at Rwakobo Rock, Lake Mburo, Uganda on 11 April 2021.

Records not proven

The following records were not accepted because the details provided were insufficient to establish the identification with certainty:

Crested Honey Buzzard *Pernis ptilorhynchus*

Singles at Nguuni Nature Sanctuary, Mombasa County on 30 January 2021, and at Vipingo Quarry, Mombasa County on 1 February 2021. Photographs confirmed that the birds were different individuals, but in both cases it was not possible to determine whether they were pure Crested or hybrid Crested x European Honey Buzzard *P. apivorus*.

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Stuart, S.N., Jensen, F.P., Brøgger-Jensen, S. & Miller, R.I. 1993. The zoogeography of the montane forest avifauna of eastern Tanzania pp. 203–228 *in* Lovett, J.C. & Wasser, S.K. (eds) *Biogeography and ecology of the rainforests of Eastern Africa*. Cambridge: Cambridge University Press.

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Rare birds in East Africa

Records of rare birds from Kenya, Tanzania and Uganda are assessed by the East Africa Rarities Committee. Records from other countries in the region can also be submitted for review and possible publication in *Scopus*. A full account of the record should be sent to the committee Chairman, Nigel Hunter (nigelhunter74@gmail.com) and the *Scopus* editor.

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